

ROYAL COMMISSION ON ARSENICAL POISONING.

FINAL REPORT

OF THE

ROYAL COMMISSION

APPOINTED TO INQUIRE INTO

ARSENICAL POISONING

FROM THE CONSUMPTION OF BEER AND OTHER ARTICLES
OF FOOD OR DRINK.

Part I.

FINAL REPORT.

Presented to both Houses of Parliament by Command of His Majesty.



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FINAL REPORT

OF THE

ROYAL COMMISSION

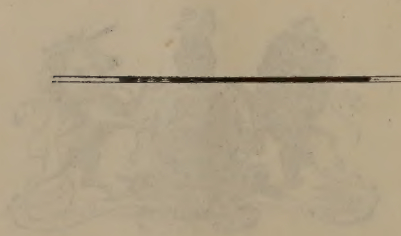
APPOINTED TO ENQUIRE INTO

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FINAL REPORT

Presented to both Houses of Parliament by Command of His Majesty



PRINTED BY HIS MAJESTY'S STATIONERS OFFICE
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THE ROYAL COMMISSION.

EDWARD, R.

Edward the Seventh by the Grace of God, of the United Kingdom of Great Britain and Ireland **King**, Defender of the Faith.

To Our Right Trusty and Well-beloved William, Baron Kelvin Knight Grand Cross of the Royal Victorian Order; Our Right Trusty and Well-beloved Councillor Sir William Hart Dyke, Baronet; Our Trusty and Well-beloved Thomas Edward Thorpe, Esquire, Companion of Our Most Honourable Order of the Bath, Principal of the Government Laboratory; Our Trusty and Well-beloved Henry Cosmo Orme Bonsor, Esquire; Our Trusty and Well-beloved William Selby Church, Esquire, Doctor of Medicine, Fellow and President of the Royal College of Physicians of London; and Our Trusty and Well-beloved Benjamin Arthur Whitelegge, Esquire, Doctor of Medicine, Fellow of the Royal College of Physicians of London, Chief Inspector of Factories and Workshops, Greeting!

Whereas We have deemed it expedient that a Commission should forthwith issue to ascertain with respect to England and Wales;

(1) The amount of recent exception sickness and death attributable to poisoning by arsenic;

(2) Whether such exceptional sickness and death have been due to arsenic in beer or in other articles of food or drink, and if so,

(a) to what extent;

(b) by what ingredients or in what manner the arsenic was conveyed; and

(c) in what way any such ingredients became arsenicated, and

(3) If it be found that exceptional sickness and death have been due to arsenic in beer or in other articles of food or drink, by what safeguards the introduction of arsenic therein can be prevented.

Now know ye, that We, reposing great trust and confidence in your knowledge and ability, have nominated, constituted, and appointed; and do by these Presents nominate, constitute, and appoint you the said William, Baron Kelvin; Sir William Hart Dyke; Thomas Edward Thorpe; Henry Cosmo Orme Bonsor; William Selby Church and Benjamin Arthur Whitelegge to be our Commissioners for the purposes of the said Inquiry.

And for the better effecting the purposes of this Our Commission We do by these Presents give and grant unto you or any two or more of you, full power to call before you such persons as you shall judge likely

to afford you any information upon the subject of this Our Commission and also to call for, have access to, and examine all such books, documents, registers and records as may afford you the fullest information on the subject; and to inquire of and concerning the premises by all other lawful ways and means whatsoever.

And We do by these presents authorise and empower you, or any two or more of you, to visit and personally inspect such places as you may deem it expedient so to inspect for the more effectual carrying out of the purposes aforesaid, and to employ such persons as you may think fit to assist you in conducting any Inquiry which you may hold.

And We do by these presents will and ordain that this Our Commission shall continue in full force and virtue, and that you Our said Commissioners, or any two or more of you, may from time to time proceed in the execution thereof and of every matter and thing therein contained although the same be not continued from time to time by adjournment.

And We do further ordain that you, or any two or more of you, have liberty to report your proceedings under this Our Commission from time to time if you shall judge it expedient so to do.

And Our further will and pleasure is that you do, with as little delay as possible, report to Us under your hands and seals, or under the hands and seals of any two or more of you, your opinion upon the matters herein submitted for your consideration.

And for the purpose of aiding you in your inquiries We hereby appoint Our Trusty and Well-beloved George Seaton Buchanan, Esquire, Doctor of Medicine, to be Secretary to this Our Commission.

Given at Our Court at Windsor the Fourth day of February 1901; in the first year of Our Reign.

By His Majesty's Command,

CHAS. T. RITCHIE.

FINAL REPORT

OF THE

ROYAL COMMISSION ON ARSENICAL POISONING.

TO THE KING'S MOST EXCELLENT MAJESTY.

MAY IT PLEASE YOUR MAJESTY,

We, the undersigned Commissioners, appointed on February 4th, 1901, to enquire into the subject of Arsenical Poisoning, do humbly submit to your Majesty our final Report.

1. In our First Report, presented in July, 1901, we set out the conclusions at which we had arrived from the evidence then received, and stated that we considered it necessary to pursue our inquiry into various administrative, scientific, and technical questions which had arisen. Since that date we have held numerous sittings, and have examined 29 witnesses, several of whom have submitted reports of scientific researches undertaken during the past two years, by themselves or by Societies or Committees whom they represented, which have been of much value to our inquiry. We have also invited and obtained information from medical officers of health, public analysts, and other officers of local public health authorities, and we have caused investigations to be conducted for our assistance.

2. In the following Report we give marginal references to Minutes of Evidence and Appendix Papers, contained in two volumes. Vol. I. comprises Evidence and Appendix Papers relating thereto received up to July, 1901, when our First Report was presented. Vol. II. comprises all Evidence, Appendix Papers and Reports received since that date. *Marginal references to the latter volume are in italic type.*

3. As in our First Report, we use for convenience the general term "food" to include also articles of drink. Where quantities of arsenic are stated, the figures given refer to arsenic reckoned as arsenious oxide.

4. We propose to report under the following heads:—

PART I.—Further observations regarding the epidemic of arsenical poisoning in 1900, and as to the medical and public health aspects of the evidence received regarding arsenic in beer and food.

PART II.—The suggested relation between the disease "beri-beri" and arsenical poisoning.

PART III.—Tests for arsenic in foods and substances used in the preparation or manufacture of food.

PART IV.—Ways in which foods are liable to become contaminated by arsenic.

PART V.--Precautions which should be taken by manufacturers to exclude arsenic from foods.

PART VI.—Present means of official control over purity of food, in relation to arsenic.

PART VII.—Recommendations as to improvements in official control over the purity of food.

PART VIII.—Recommendations as to the proportions of arsenic in food which should now be held to constitute an offence under the Sale of Food and Drugs Acts.

PART I.

FURTHER OBSERVATIONS REGARDING THE EPIDEMIC OF ARSENICAL POISONING IN 1900, AND AS TO THE MEDICAL AND PUBLIC HEALTH ASPECTS OF THE EVIDENCE RECEIVED REGARDING ARSENIC IN BEER AND FOOD.

CAUSATION OF THE EPIDEMIC OF 1900.

5. In our First Report we dealt in some detail with the evidence received as to the cause of the serious epidemic of poisoning which occurred in the latter part of 1900, and which led to the appointment of this Commission. As we then showed, the epidemic, as such, was due to arsenical contamination of beer at numerous breweries through the use of brewing sugars, glucose or "invert" sugar manufactured by a single firm, that of Bostock & Co., of Garston, near Liverpool. The arsenic was introduced into Bostock's brewing sugars, by way of a highly arsenical sulphuric acid, which had been used in their manufacture for some eight or nine months before the date on which it was first suspected that the sugars in question had been the means of producing poisoning by reason of the beer prepared from them. The arsenical sulphuric acid had been supplied to Bostock & Co. by the firm of Nicholson and Sons, chemical manufacturers, of Leeds. As regards the cause of the epidemic, and the steps taken by public health authorities, brewers, and others to bring it to a speedy termination, we have nothing to add to our former report.

DISPOSAL OF BOSTOCK'S BREWING SUGARS.

6. Shortly after the appointment of the Commission, we learnt that the firm of Bostock and Co. was in liquidation. Realising the importance of preventing any risk of further poisoning, we requested the liquidators to keep the Commission informed of the action taken when the large stock of glucose and "invert" sugar remaining at the works (over 700 tons) came to be disposed of. In May, 1901, however, evidence which we received from the former Secretary of the Company regarding the precautions which had been adopted in selling the small amount of contaminated glucose which had then already left the works, and the result of inquiries by Mr. H. Hammond Smith, who visited Bostock's factory on our behalf, seemed to us unsatisfactory. We therefore at once made strong representations to the official liquidators and communicated with the Local Government Board, who instituted inquiries.

Williamson, 7300-32.
H. Smith, 10932.

As a result of this action, very stringent precautions were adopted by the liquidators. By November, 1901, all the contaminated glucose and "invert" sugar had been sold, and had been consigned directly to manufacturers for use in textile and other purposes unconnected with food; particulars regarding each sale, and the undertakings entered into respecting the use of all sugars sold, having been systematically communicated by the liquidators to the Commission and to the Local Government Board.

BOSTOCK'S "TABLE SYRUP."

7. In 1900, Messrs. Bostock & Co. had commenced to manufacture preparations resembling treacle, termed "Table Syrups." These were flavoured with various fruit essences and put up in 2-lb. tins for sale. The syrup used was cane sugar which had been "inverted" by Nicholson's sulphuric acid. Fortunately, at the date of the discovery of arsenic in their brewing sugars scarcely any of these table syrups were on the market. A trial series of tins had been sent out to retailers, but in most instances the syrup in the tins was found to have become

H. Smith, 10971-32.
Appx. 25, p. 265.

solidified through some accident in the manufacture, and in consequence the bulk of the tins had been returned to the factory. In May, 1901, when Mr. H. Hammond Smith visited Messrs. Bostock's works, he found tins of these syrups to the extent of 14 tons on the premises. Samples tested for the Commission by Dr. McGowan showed approximately one grain of arsenic to the pound of table syrup. Following on the representations mentioned above, all these tins of syrup were burnt by order of the liquidators.

EXTENT, DISTRIBUTION, AND FATALITY OF THE 1900 EPIDEMIC.

8. *Evidence of Witnesses.*—The Medical Officer of Health of Manchester, after inquiries of medical men practising in the city, computed that at least 2000 persons in Manchester had suffered by the epidemic. Dr. Tattersall by similar enquiries reckoned about 1000 cases in the Borough of Salford. The Medical Officer of Health of Liverpool informed us of at least 100 cases treated in public institutions which were undoubtedly arsenical poisoning; he was, however, unable to estimate the total number of persons who were attacked in Liverpool. They were certainly numerous, but probably fewer in number than in Manchester. Dr. G. Reid as a result of inquiries from Medical Officers of Health in Staffordshire learnt of over 660 cases in that county. Dr. Sergeant by similar means collected information regarding 950 cases in the administrative County of Lancaster.

9. *Information obtained by Circular Letter.*—In May, 1901, by circular letter, we invited Medical Officers of Health of all local sanitary authorities in England and Wales to furnish us with information as to recent arsenical poisoning attributed to beer. Out of a total of 1148 boroughs, urban and rural sanitary districts* making returns in answer to our communication the Medical Officer of Health had made inquiries, with negative results, in 874, including 37 County Boroughs. In other instances the return stated that no inquiry had been made.

No cases were reported from any of 36 English administrative counties or from London. Two cases were reported from Essex, four from Warwickshire, and four from Wales. Practically speaking, no breweries in these 39 counties or in London had been customers of Bostock & Co.

On the other hand, cases were reported from numerous urban and rural districts noted in Table A below, and from the County Boroughs named in Table B.

TABLE A.

ADMINISTRATIVE COUNTIES IN WHICH ARSENICAL POISONING WAS REPORTED FROM ONE OR MORE DISTRICTS.

ADMINISTRATIVE COUNTIES.	Number of districts in the County in which Inquiry was made by Medical Officer of Health.	Number of districts in which Result of Inquiry was negative.	Number of districts in which cases of Arsenical Poisoning were reported.	Total Numbers of Cases where estimated.
				About or Over.
Cheshire - - - -	35	31	4	48
Cumberland - - -	21	17	4	121
Derbyshire - - -	27	25	2	7
Lancashire - - - -	77	52	25	†650
Monmouthshire - -	18	17	1	30
Nottinghamshire -	11	8	3	27
Shropshire - - - -	17	16	1	32
Staffordshire - - -	40	24	16	†355
Wiltshire - - - -	19	18	1	—
Yorkshire (W.R.) -	79	71	8	196
TOTALS - - - -	344	279	65	1,466

* According to the census of 1901, the total number of urban and rural districts in England and Wales, including 67 County Boroughs, is 1815.

† Information obtained independently by County Medical Officers of Health shows that the total of cases in the count was much larger than this figure—see above.

TABLE B.

COUNTY BOROUGHES IN WHICH CASES OF ARSENICAL POISONING
WERE REPORTED.

COUNTY BOROUGHES.	Number of Cases of Arsenical Poisoning, where estimated : about or over.	COUNTY BOROUGHES.	Number of Cases of Arsenical Poisoning, where estimated : about or over.
Birkenhead - - -	100	Oldham - - -	8
Birmingham - - -	4	St. Helen's - - -	6
Blackburn - - -	15	Salford - - -	996
Bolton - - -	9	Sheffield - - -	32
Bury - - -	16	Stockport - - -	2
Chester - - -	35	Walsall - - -	4
Hanley - - -	5	Wigan - - -	6
Liverpool - - -	?	Wolverhampton - - -	7
Manchester - - -	2,000	TOTAL - - (over)	3,245

Medical Officers of Health, in giving estimates of the number of cases which occurred in their districts, have in many instances been careful to point out that there must have been others which did not come to their notice.

10. *Summary as to extent of Epidemic.*—The information obtained from the above sources shows that, if allowance is made for about 1000 cases in Liverpool, the total number of persons who suffered in consequence of the epidemic was certainly 6000, and probably the number was in fact very considerably greater.

11. *Fatal Cases.*—It is impossible to determine the fatal cases of this epidemic with any approach to accuracy. Information received from various sources, including the returns from Medical Officers of Health above referred to, shows that a total of 70 fatal cases occurred which were attributed to poisoning by arsenic in beer. In nearly all these cases arsenical poisoning was entered in the death certificate as the cause or as one of the causes of death, or was found to be a cause of death as the result of a Coroner's inquest.

It is evident, however, that deaths thus certified do not represent the total number of cases in which death resulted from, or was accelerated by, poisoning due to arsenic in beer. Deaths occurring before the discovery of the cause of the outbreak were frequently certified as due to "chronic alcoholism," and "cirrhosis of the liver," and in some cases were attributed to Addison's disease and locomotor ataxy. Other deaths were recorded as due to "alcoholic," "peripheral," or "multiple" neuritis.

It might be expected that an approximate estimate of the share of arsenical poisoning in producing deaths recorded as due to such causes as cirrhosis of the liver, chronic alcoholism, and neuritis in the localities principally affected could be obtained by comparing the mortality figures for 1900 with those of previous years. Dr. Tatham has furnished us with data regarding deaths from these causes which were specially extracted at the Registrar General's Office for the year 1900. Unfortunately, however, the Registrar General's customary classification of causes of death does not separately distinguish deaths from the diseases in question, and we have no data available in respect of years antecedent to 1900 with which to make the comparison desired.

Tattersall, 48-55.
Niven, 491.
Sergeant, 4128, 4233-4.
Raw, 6306-7.
Reynolds, 8421-31.

Tatham, 2537-50.

12. *Effect of the Epidemic on the Birth Rate.*—Dr. Niven has put before us statistics regarding an unusual and considerable fall in the birth rate for the year 1901, in the boroughs of Manchester, Salford, and Liverpool, which he is inclined to regard as the result of the epidemic of the previous year in view of a number of data which he supplies. The decrease in the birth rate in each borough was strongly marked during the third quarter of 1901, and was manifested, though to a less degree, in the second and fourth quarters; the period during which a large portion of the beer in these cities was seriously contaminated being some six or eight months before November, 1900, and the greatest amount of sickness due to arsenical beer having occurred in the fourth quarter of 1900. On comparison with London and with thirteen large towns which were only slightly, if at all, affected by the 1900 epidemic, Dr. Niven found that in no instance had there been any fall of birth rate in the third quarter of 1901 at all comparable in extent to that which occurred in Manchester, Salford and Liverpool. Moreover, when the rates in the several sub-areas of Manchester came to be examined, the fall in birth rate in the third quarter of 1901 was seen to be greater in particular parts of Manchester which were known to have been most seriously affected by the epidemic of the year before.

SYMPTOMS OF POISONING DUE TO ARSENIC IN BEER DURING THE EPIDEMIC OF 1900.

13. It is obvious that during the epidemic the conditions under which different individuals came to suffer in consequence of drinking arsenical beer must have varied largely. There were great differences in individual cases as regards the quantity of arsenic in the beer consumed, the amount of beer taken, and the duration of the period over which arsenical beer was drunk; and there were also further differences between individual beer drinkers—*e.g.*, as to age, sex, health, conditions of nutrition, and habits as regards alcohol—which determined the extent of their susceptibility to arsenical poisoning at the time when they began to take beer containing arsenic.

Vol. I, Index,
"Symptoms."

Corresponding to these and other differences, the disease produced by the arsenical beer during the epidemic varied greatly in its manifestations. In our minutes of evidence are brought together a series of detailed descriptions by careful medical observers of individual cases of poisoning, of different clinical types which they have distinguished, of particular symptoms met with at different stages of the malady produced, and of pathological changes observed *post mortem*. The descriptions given by these observers—notably by Drs. Reynolds, Stevenson, Luff, Dixon Mann, Kelynack, Raw, and Sir L. Brunton—deserve careful attention, and form valuable material for reference and comparison in future cases or future outbreaks, where the possibility of arsenical poisoning calls for consideration.

14. These accounts show on the one hand, that there occurred throughout the epidemic (and particularly it would seem towards its termination, when people had been drinking arsenical beer for many weeks or months and so had taken considerable quantities of the poison), an abundance of cases in which, once the possibility of arsenic was entertained, there was comparatively little difficulty in deciding, on clinical grounds, that the illness was consistent with arsenical poisoning. Such cases presented symptoms corresponding to those described as characteristic of subacute poisoning by arsenic, or which are met with in the poisoning which occasionally results from long-continued doses of arsenic taken medicinally. They showed, for example, inflammation of various mucous surfaces—leading to coryza, huskiness, lachrymation, and the like; gastro-intestinal disturbance and diarrhoea; peripheral neuritis affecting sensory and motor nerves, and in some cases associated with herpes or with well-marked erythromelalgia; keratosis; or recent pigmentation corresponding to that which not infrequently occurs in persons taking arsenic for long periods.

15. On the other hand, symptoms of the above kind were often slight or absent altogether, and one of the most instructive points in connection with the outbreak is the occurrence of cases in which the symptoms, if taken by themselves and apart from the epidemic, would not have appeared to be readily or sufficiently explained by the suggestion that arsenic was the cause of illness. Thus in several comparatively mild cases, the sufferers complained merely of burning hands and feet, or they showed a variety of skin eruptions which are observed in many conditnios which have nothing to do with arsenical poisoning. In other cases, again, the main symptoms were those resulting from dilated heart; and special difficulty arose in cases showing evidence of well-marked peripheral neuritis not associated with symptoms pointing clearly to arsenic, and which appeared practically identical with "alcoholic neuritis," a disease previously considered to be the result, alike in drinkers of beer and spirits, of the toxic action of alcohol on nerve tissue.

Vol. I, Index.
"Heart."
"Alcoholic Neuritis."

POISONING FROM ARSENIC IN BEER, APART FROM THE EPIDEMIC OF 1900.

16. *Prevalence of Alcoholic Neuritis in certain parts of England before 1900, and its relation to Arsenic.*—It is evident that the circumstance that medical men in the localities affected by the epidemic were in most instances familiar with the disease "alcoholic neuritis" was largely responsible for the delay which occurred in recognising the nature of the outbreak and in referring it to arsenic. When they found that a considerable number of cases of peripheral neuritis were coming under their observation in 1900, the matter did not present itself to them in the same striking aspect as it would have done had they been dealing with a form of disease which was new in their experience. Medical witnesses dealing with prevalence of alcoholic neuritis in Manchester and Liverpool before 1900 (and, therefore, before Messrs. Bostock & Co. employed highly arsenical acid in the preparation of their brewing sugars), have laid much stress on the relatively frequent occurrence of this disease in these cities when compared with London, with Scotland, or with large centres of population in the South of England, and on review of the evidence which we have received, we think there can be no doubt of the fact. The material which we have obtained does not suffice, however, to admit of its expression statistically. Alcoholic neuritis, unlike infectious fevers, is not a notifiable disease; the mortality statistics of the Registrar General do not discriminate deaths due to alcoholic neuritis, as we have said; a large number of cases find their way to Poor Law Infirmaries where little record has been kept of them, and in the case of Hospitals or Infirmaries where data are available, many opportunities of fallacy arise when the experience of one institution is compared with that of another. Such comparative data as we have obtained however are consistent with the medical evidence to which we have referred. Evidence in the same direction has been furnished us by members of the medical staff of several large provincial hospitals in southern and eastern counties, who in each instance have written that in their experience of private and hospital practice alcoholic neuritis is a disease of extremely rare occurrence.

Vol. I, Index,
"Alcoholic Neuritis."

17. The "alcoholic neuritis" thus formerly prevalent in Manchester and Liverpool had for some years before 1900 been recognised locally as a disease affecting beer drinkers far more than spirit drinkers, and the relation of this circumstance to arsenic requires to be considered.

Tattersall, 72-3.
Reynolds, 344.
Kelynack, 3573.
Raw, 6356.

18. There can be no doubt that a considerable proportion of beer brewed in some parts of the country before 1900 contained noteworthy quantities of arsenic, mainly derived from malt and from brewing sugars. It is also evident that before 1900 the degree to which beer has been liable to receive arsenic from malt must have varied greatly in different parts of England. Malt has been shown to have been subject to arsenical contamination in much greater degree when the fuel used on

Vol. I, Index
"Beer, Arsenic in."

cf. paras. 87, 93, 97, below.

Vol. I. Index,
"Malt," "Fuels."

Salamon, 1343-6.
Tomson, 3094-9.
Miller, 3407-13.
Estcourt, 3981-7.
C. Brown, 6710.

the kiln has been gas coke than when other forms of malting fuel (oven coke or anthracite) have been employed, and it may safely be concluded that the quantity of arsenic introduced into beer through malt has been in the past greater where brewers have made beer from malt dried over gas coke. In maltings in the Southern Counties of England the use of gas coke has never been common, but in certain parts of the North and Midlands of England gas coke was habitually used before 1901, and in the cities we are now considering, Manchester and Liverpool, gas coke was constantly employed at the maltings supplying various breweries. Our evidence shows that Manchester and Liverpool brewers habitually obtained large quantities of malt from Yorkshire maltings where local gas coke was used, and that in 1900 certain of these malts were found to contain considerable quantities of arsenic. Brewers in Manchester and elsewhere, who on the discovery of the cause of the epidemic took steps to secure that their brewing sugars were free from arsenic,—or who for a time abandoned the use of brewing sugars altogether—found nevertheless that they could not produce beer which could be regarded as practically free from arsenic until they had discontinued the use of malt which had been dried over this fuel. It may be concluded, therefore, that the fact of greater prevalence of alcoholic neuritis among beer drinkers in Manchester and Liverpool before 1900 when compared, for example, with London and places in the Southern Counties, is consistent with the explanation that (whatever may have been the case with regard to brewing sugars) the degree to which beer was likely to become contaminated by arsenic was greater in these two cities owing to the larger proportion of arsenic contained in much of the malt there used.

Diminution in "Alcoholic Neuritis" and "Alcoholic Heart" in Manchester since the epidemic of 1900.

Vol. I. Index,
"Brewers."

Reynolds, 8227-9, 8322-58
8402.

19. Very stringent precautions were taken by brewers in Manchester after the discovery of the cause of the epidemic to secure that the various ingredients of their beer were satisfactory as regards arsenic, and it is certain that beer consumed in Manchester during and since 1901 has been far better in respect of arsenic than was the case before the highly-contaminated Bostock brewing sugars came on the market in 1900. If, therefore, arsenic in beer had been in any measure responsible for "alcoholic neuritis" in Manchester before 1900 it was to be expected that the prevalence of this disease would be found to show a marked diminution in 1901 and 1902. The later evidence of Dr. Reynolds, who put before us his experience at Crumpsall Infirmary and at the Manchester Royal Infirmary, and also the opinions of other physicians practising in Manchester, leaves no doubt that this in fact has been the case. Save for persons who had suffered during the epidemic, he had been unable to ascertain the existence of any alcoholic neuritis among beer drinkers in 1901. His evidence is instructive also by showing that in Manchester there has occurred, in parallel fashion, a marked diminution in certain other disease conditions which before the 1900 epidemic had not been associated with arsenic in beer. He drew particular attention to a morbid condition termed "alcoholic heart" which had long been recognised in Manchester as occurring among beer drinkers. Patients presenting symptoms of this characteristic affection of the heart (with or without other marked symptoms of illness) had been specially numerous during the 1900 epidemic; after the epidemic these cases practically ceased altogether.

Arsenical Poisoning in Halifax in 1902.

20. In January, 1902, the attention of the Commission was directed to statements that cases of illness attributed to arsenical beer had occurred among patients recently admitted to the Poor Law Infirmary at Halifax. Local inquiry was made on behalf of the Commission by Mr. H. Hammond Smith, who presented a detailed report giving the results of his observations, and the information which he had collected from

Reynolds, 8403-42.
H. Smith, 8628-847.
Thorpe, 8847.
Thompson, 8848-9089.
Neech, 9090-265.

medical men, analysts, local officials, brewers, maltsters, and others. This report was considered at our meeting on March 21st, and on April 11th and 18th we heard various witnesses on the subject, including the Medical Officer of Health of Halifax and the brewers principally concerned, to whom copies of Mr. Hammond Smith's report had previously been sent. We also received an account of a series of analyses of Halifax beer and brewing materials which were made at the Government Laboratory in consequence of the outbreak.

*Buckley, 9266-419
Worsick, 9240 99.
Fairley, 9923.*

21. The principal facts were as follows: In January and February, 1902, eight cases came under notice in Halifax Poor Law Infirmary, and some five or six other cases were heard of in the borough, in which poisoning by arsenic in beer was suspected. The majority of these cases, including three which proved fatal, presented symptoms pointing unmistakably to arsenical poisoning; the remainder were in all probability to be referred to the same cause.

All the persons attacked were beer drinkers, and in most instances heavy beer drinkers. There was no reason to suspect that they had received arsenic otherwise than through beer, while there was strong evidence that the beer they had consumed had been arsenical. Samples of beer taken in January, 1902, from public-houses frequented by certain of these cases were found to contain between $\frac{1}{40}$ th and $\frac{1}{16}$ th of a grain of arsenious oxide per gallon. Inquiry was made as to the origin of the various beers which had come under suspicion. They were traced back to particular breweries, and the source of the materials used in the brews which were specially implicated was ascertained. In some of these brews glucose or "invert" sugar had been used, but these had been supplied by different manufacturers, and the evidence gave no indication that the beers in question had obtained their arsenic by way of brewing sugars. None of the breweries concerned had been customers of Bostock & Co. in 1900. In two beers containing respectively $\frac{1}{16}$ th of a grain and $\frac{1}{35}$ th of a grain of arsenic per gallon no brewing sugar had been used.

*H. Smith, p. 17.
Thorpe, pp. 30-31.
Fairley, 9743.*

22. On the other hand, the facts pointed strongly to the conclusion that the implicated beers had been contaminated by arsenic derived from malt used in their preparation. In nearly every instance there was evidence that the malt concerned had been dried over local gas coke, and that the brewer, before using it, had taken no precautions to ascertain its condition as regards arsenic. In several cases the malt which was actually in use at the brewery at the date of inquiry had been recently made, in the 1901-2 malting season, and had been dried over anthracite, and specimens of such malt which were available for chemical examination were not found to be highly contaminated by arsenic. But on closer inquiry at these breweries it was found that the malt which had been used in the implicated brews was of a different character, as it had been dried in the previous malting season, 1900-1, and over gas coke; and at some maltings in the Halifax neighbourhood gas coke was still used in 1902. One large brewery, making its own malt, was using as much as 85 per cent. of gas coke for malt drying; at another it was found that gas coke was used when a sufficient supply of anthracite was not available.

*Thompson, 8933-6.
H. Smith, 8764.*

23. Certain samples of malt which appeared to correspond to those which had been used in the beers under inquiry showed amounts of arsenic such as $\frac{1}{60}$ th of a grain per lb. In one instance, that of a "publican-brewery" called the "Cross Keys," it was shown that in the implicated beer the brewer had used malt, in the proportion of 2 lbs. of malt to the gallon of beer, which had been purchased from Mr. Firth, a maltster, without guarantee or analysis as to arsenic. A sample of this beer taken in January, 1902, was found to contain $\frac{1}{16}$ th of a grain of arsenic to the gallon. Mr. Firth had made the malt in question in the season of 1900-1901; on the single occasion on which he had sent a sample of malt made during that season to be examined for arsenic the analyst had reported as much as $\frac{1}{36}$ th of a grain of arsenic to the lb.

in it. It also appeared that the malt ultimately supplied by Mr Firth to the "Cross Keys" had been rejected by a brewer in Lancashire on account of the arsenic it contained.*

24. Looking to all the evidence received in respect of the Halifax outbreak, and to the accumulated facts which show the extent of arsenical contamination to which malt is liable when prepared without adequate precautions to exclude arsenic (particularly when dried over gas coke as was the case here), we are satisfied that the arsenical poisoning in Halifax was attributable to beer contaminated by arsenical malt used in its preparation.

25. The fact that in an important borough such as Halifax, within twelve months of the epidemic of 1900, the steps taken by the brewers and by the public authorities alike proved to be insufficient to safeguard the public against beer which was dangerously contaminated by arsenic, has an important bearing on our inquiry, and we refer to it later on in this report. Here we would draw attention to the evidence it has afforded that poisoning by arsenic in beer even now may easily pass undetected, notwithstanding that a number of cases may be occurring in the same place at about the same time. The nature of the cases in the Poor Law Infirmary would very likely not have been established but for the fact that the resident Medical Officer, Dr. J. F. Hodgson † had experience of arsenical beer poisoning in Manchester in 1900. The Medical Officer of Health had no knowledge that there were cases of suspected arsenical poisoning in the Poor Law Infirmary until inquests were held, and thus it was a mere accident which led to his making special inquiry of medical practitioners in the Borough, with the result of ascertaining that cases had occurred outside the Infirmary.

Paras 154-6, below.

ALCOHOLIC NEURITIS APART FROM ARSENICAL POISONING.

26. The fact of this small outbreak at Halifax strengthens the opinion which we have above expressed, that much of the alcoholic neuritis occurring among beer drinkers before 1900, and particularly in localities such as Manchester, was attributable to arsenic in beer. Clinically, almost all the Halifax cases were characterised by peripheral neuritis, which, taken by itself, was hardly to be distinguished from "alcoholic neuritis." Moreover, the Halifax beers associated with the outbreak must have been typical in respect of arsenic of a large class of beers prepared before the 1900 epidemic from arsenical malt.

27. In our view it is important that the question of arsenic should be fully considered in all cases of peripheral neuritis attributed to beer drinking. To what extent beer free from arsenic is capable of producing neuritis among heavy drinkers the data at our disposal do not suffice to permit an opinion to be given. We are unable to accept the thesis of some witnesses that there is, practically speaking, no "alcoholic neuritis" apart from arsenic. Inquiries which we have made as to the experience of London and provincial hospitals show that cases of alcoholic neuritis are met with from time to time in which the alcoholic liquor consumed has been exclusively spirits. All the evidence adduced is to the effect that spirits are not liable to contain arsenic.

Kelynack, 3484.
Reynolds, 8338.

* A copy of Mr. Hammond Smith's Report was sent in March, 1902, to Mr. Firth, who was then offered an opportunity to give evidence to the Commission. Mr. Firth however, wrote that he was prevented by personal circumstances from attending to give evidence.

† At the Coroner's inquests which were held, the brewers concerned used various means to obtain a verdict that the cases were not due to arsenical poisoning and to discredit Dr. Hodgson's statements. They secured some support from Mr. J. F. Woodyatt, the visiting Medical Officer of the Infirmary, who threw doubt on the correctness of the diagnosis which had been made in one or two of the cases in question. After hearing evidence from Mr. Woodyatt, however, we are unable to attach importance to the points which he raised.

H. Smith, 8838-43.

H. Smith, p. 16: 8635.
Woodyatt, 9491-651.
Neech, 9146-70.

As regards arsenical beer, it may be conjectured—and this has been the opinion of many of the medical witnesses whom we have examined on the subject—that when small doses of arsenic are taken for a long time together with considerable quantities of alcohol, the arsenical poisoning liable to result will be manifested more frequently and more conspicuously by peripheral neuritis than if the arsenic had been taken without the alcohol. In this connection it is interesting to note an account which we have received of an epidemic of arsenical poisoning at Hyères in 1887, in which the sufferers presented symptoms very closely parallel to those observed during the epidemic of 1900. At Hyères numerous cases of paralysis occurred, and it was an alcoholic drink, wine, which was contaminated by arsenic and which caused the outbreak.

Luff, 2859, 2938.
Kelynaek, 3564.
Brunton, 5944.
Raw, 6304-12.
Delépine, *Appx.* 16.

Appx. 14, p. 359.

FORM IN WHICH ARSENIC IS PRESENT IN ARSENICAL BEER.

28. The suggestion has been made that certain clinical manifestations of poisoning from arsenic in beer may have resulted from the presence in the beer of some compound of arsenic with organic matter possessing toxic action differing from arsenious oxide: for example, causing less irritation of mucous surfaces, or a greater degree of neuritis. In the opinion of several chemical witnesses it is not unlikely that arsenic may exist in beer in combination with organic matter (para. 54, below). But we have received no evidence that any such compound has actually been separated, or that its chemical and toxicological properties have been ascertained. In the absence of knowledge on these points, we see no reason to assume from merely clinical data that poisoning by arsenious oxide in beer would of itself have been insufficient to explain the morbid conditions observed. It should be observed in this connection that several chemists have sought for evidence of the presence of derivatives of cacodyl, or of substances akin to cacodyl in which arsenic exists in comparatively stable combination with alcohol radicles, both in arsenical beer such as that prepared with Bostock brewing sugars, and in beer and wort to which arsenious oxide was added under experimental laboratory conditions. The results of these investigations have been negative. Cacodylates, it should be noted, in proportion to the arsenium they contain, are relatively much less toxic than is arsenious oxide.

Vol. I. Index,
"Organic Matter."
Vol. II. Index,
"Organic Matter."

Salamon, 1374, 1518.
Delépine, 5232-4, 10,321-5.
Hooper, 7806-8.
Hehner, 8044.

INDIVIDUAL SUSCEPTIBILITY TO ARSENIC.

29. Great differences exist between individuals in their susceptibility to poisoning by arsenic, and this fact is abundantly illustrated in our evidence. Instances of tolerance of large medicinal doses (such as even 30 minims of *liquor arsenicalis*, or $\frac{3}{10}$ ths grain of arsenic, two or three times a day) have, for example, been reported to us by Dr. Stevenson and Professor Delépine; and the well-known accounts of the tolerance of arsenic by Styrian peasants have been frequently referred to. The epidemic of 1900 itself afforded many instances of tolerance; indeed, one of the most striking facts of the epidemic was that large numbers of people must have been drinking beer, much of which was contaminated by arsenic to a high degree, in considerable quantities over several months without any apparent bad result. Another illustration of tolerance of arsenic appears to be furnished by the comparative rarity of severe poisoning among workmen engaged in recovering arsenic in arsenic-roasting works in Cornwall, and in the manufacture of arsenical pigments and sheep dips. Other factors beside personal insusceptibility have to be taken into account in these cases, particularly the precautions which are adopted to prevent inhalation of dust, and the insolubility of certain of the arsenical compounds which are liable to be swallowed; but when allowance is made for these, it is still remarkable that the poisoning reported among arsenic workers appears in most instances to be confined to catarrhal affections of the throat and upper air passages; peripheral neuritis and other symptoms of chronic arsenical poisoning such as were met with in the 1900 epidemic being almost entirely absent.

Stevenson, 2452.
Delépine, 5307.

Roscoe, *Memoirs*
Lit. Phil. Soc.
Manchester, 1860.

Legge, 11,733-334.

Tattersall, 19.
Stevenson, 2433.
Mann, 3798.
Neech, 9264 5.

30. On the other hand, numerous instances of exceptional susceptibility to poisoning by arsenic have been brought to our notice, including, for example, such instances as symptoms of poisoning following the medicinal administration spread over several days of a total quantity of arsenic no more than $\frac{1}{8}$ th of a grain, or, in another case, following a single dose of $\frac{1}{50}$ th of a grain. Paralysis has been reported to have followed taking a daily dose of 10 minims of *liquor arsenicalis* ($\frac{1}{10}$ th grain of arsenic) for three weeks. There can be no doubt that many of the persons who suffered during the epidemic—especially severe cases in which no more than one or two pints of beer daily had been consumed—were individuals specially susceptible to arsenical poisoning.

Vol. I., Index,
"Epidemic."

31. It has been suggested that during the 1900 epidemic women showed a greater susceptibility to arsenical poisoning than men. Although we have received particulars of the number of men and women respectively who were admitted to several hospitals and infirmaries suffering from arsenical poisoning, we have not data sufficient to show whether as a matter of fact in any large population affected by the epidemic a greater total number of cases occurred among women. Still less do the facts available enable a contrast to be drawn between the incidence of poisoning in men and women when account is taken of the relative proportion of beer drinkers in each sex, and of the quantity of beer habitually taken by men and women respectively. There can, however, be no doubt of the fact that as a whole women in 1900 suffered more severe attacks than men, and an altogether disproportionate number of fatal cases occurred among women. One explanation is that whereas the men often resorted to a number of different public-houses, and so got beer from different breweries which was sometimes contaminated by Bostock sugars and sometimes not, the women drank beer at home which they habitually obtained from the same public-house, so that often all their beer was arsenical. Apart from this, it has been suggested as a reason that women eliminate arsenic less rapidly owing to their taking comparatively less exercise, and that their apparently greater susceptibility may be due to their taking less food than men.

Appx. 16, p. 183.
Delépine, 10,387-423.

32. Professor Delépine in 1902 communicated to us the result of a long and interesting series of observations in his laboratory on the effect of administration to rats of known and varying quantities of arsenic, both in watery solution and in beer, along with suitable control experiments. These observations deserve study in relation to the question of individual susceptibility. Prof. Delépine found that minute quantities of arsenic could be administered over comparatively long periods before detrimental results appeared, so long as the experimental animal was taking an abundance of food: whereas in rats under identical conditions but on comparatively restricted diet the deleterious effects of the arsenic were much sooner apparent. In the case of rats taking arsenic he found that beer, rather than being detrimental, appeared to increase the resistance of the rats by improving nutrition.

ACCUMULATION OF ARSENIC IN HUMAN TISSUES, AND WAYS IN WHICH ARSENIC IS ELIMINATED.

Stevenson, 2219-60.
Mann, 3782-3.
Delépine, 5314.

33. In a few of the Manchester cases which terminated fatally, certain of the viscera were tested for arsenic by Dr. Stevenson and by Dr. Dixon Mann. Small, though weighable, quantities of arsenic ($\cdot 011$ grain in $13\frac{1}{2}$ ounces) were recovered from the viscera examined (liver, spleen, and portions of intestine) in one instance, where death had taken place six days after the patient ceased to take arsenical beer; in three other cases, where death had taken place respectively 14, 32, and 52 days after beer ceased to be taken, arsenic was detected in the viscera examined, but was present in amounts too small to be weighed. In one case—a woman presenting well-marked symptoms of arsenical poisoning during life, who died 23 days after ceasing to take beer—no arsenic at all was detected in the viscera tested.

So far as the particular organs examined are concerned, these results accord with the generally-accepted view that arsenic is a poison which, as a rule, is eliminated comparatively rapidly from the body—by contrast, for example, with such a “cumulative” poison as lead, which, when taken in small doses over long periods, becomes stored in the liver and elsewhere.

* 34. On the other hand the clinical data obtained during the epidemic show that arsenic can only be termed a “non-cumulative” poison in a restricted and comparative sense. It is necessary for their explanation to assume that when small quantities of arsenic are taken over long periods, accumulation does take place in certain tissues. Many of the cases admitted to hospital in 1900 continued to show increasing signs of poisoning for weeks after beer had been discontinued. In some cases there was a recurrence of symptoms of arsenical poisoning after the patient had almost recovered, no beer or arsenic having been taken for many weeks. An examination of the urine in several cases showed that arsenic could be detected three weeks or more after the patient had been admitted to hospital, while in an exceptional instance Dr. Dixon Mann found arsenic in the urine after fifty-nine days.

Raw, 6327-33.

Kelyack, 3571.
Mann, 3731-3.
Raw, 6336-40.
Reynolds, 8450-3.

35. Important observations have been made in several cases regarding the numerous ways in which arsenic may be eliminated from the body. Arsenic was detected in sweat, in the epidermic scales which are freely shed in the condition known as keratosis, in nails, and in hair. It appears probable, as Dr. Dixon Mann has pointed out, that epidermic tissues which principally consist of keratin, have a special affinity for arsenic, and that the effect of arsenic upon nerve tissue may be related to the fact that nerve sheaths consist largely of keratin.

Vol. I., Index, “Elimination.”
Reynolds, 8296-314.
Appx. 16, p. 188.

Mann, 3737.

Elimination of Arsenic by the Hair.

36. The fact of arsenic being excreted by hair appeared to us of special interest. If it were established that persons taking comparatively small quantities of arsenic habitually excrete the poison in their hair to an extent which is readily appreciable by chemical tests, examination of hair might be of much value in cases where it is important to obtain indications of the past history of a patient in regard of arsenic. Accordingly we took steps to obtain, with the aid of the Medical Registrars of certain London Hospitals, and the Medical Superintendents of certain London Infirmarys, samples of hair from patients who had taken arsenic in known amounts over known periods of time, together with suitable controls, and we engaged the services of Mr. R. F. Wood Smith to analyse these hair samples for arsenic.

Mann, 3737.
Appx. 32, p. 345.

37. The results of these experiments, reported in Appendix No. 32, are instructive. Out of a total of 41 control cases, principally hospital and infirmary in-patients, both males and females, who had been taking no arsenic medicinally, the hair of 38 was either free from arsenic according to the tests employed, or showed no more than $\frac{1}{150}$ th grain of arsenic per pound of hair (0.96 parts per million). Only three showed larger amounts (viz., $\frac{1}{100}$ th, $\frac{1}{50}$ th, and $\frac{1}{25}$ th grain per pound, respectively). Samples of hair were obtained from the same cases after they had taken arsenic medicinally. Male patients who had been taking three minims of *liquor arsenicalis* three times a day (about $\frac{1}{10}$ th grain of arsenic daily), at the end of two months showed amounts of arsenic varying from $\frac{1}{20}$ th grain to $\frac{1}{5}$ th grain per pound in hair which had grown during the interval, with the exception of one case which showed $\frac{1}{50}$ th grain per pound. Male patients taking smaller amounts of arsenic medicinally—three minims or four and a-half minims of *liquor arsenicalis* ($\frac{1}{3}$ rd and $\frac{1}{2}$ nd grain of arsenic) daily—for two months, also showed notable amounts of arsenic, varying from $\frac{1}{80}$ th to $\frac{1}{10}$ th grain per pound in their recently-grown hair.

In the case of female patients under like conditions, considerable difficulty arose in obtaining samples which represented the hair

which had grown during the period of arsenic taking, but the results, though less uniform than in the male cases, were similar in character.

The results of testing hair of cases, both male and female, in which arsenic had been taken for less than five weeks, were much more irregular, owing, no doubt, to the fact that the sample examined usually comprised an uncertain proportion of hair which had grown before the administration of arsenic had begun.

Hair was also examined in a considerable number of cases in which no "controls" were available, arsenic having already been taken in varying amounts for considerable periods of time at the date of collection of the hair specimen. Nearly always, in these cases, when portions of the hair were examined which approximately corresponded to the period during which arsenic had been taken, a relatively large amount of arsenic was detected. In some instances, arsenic was detected in recently-grown hair several weeks after the drug had ceased to be taken.

IMPORTANCE OF EXCLUSION OF SMALL QUANTITIES OF ARSENIC FROM FOOD.

38. On review of all the evidence on the subject, we are of opinion that the exclusion of small quantities of arsenic from food and drink is of greater importance than might at first sight be supposed, and calls for more attention than it has hitherto received. The question has often arisen, with reference to particular foods liable to contain a relatively minute quantity of arsenic, whether such a quantity may not be regarded as unimportant and altogether negligible, and the Commission have, as it were, been challenged to say that it can do no harm. But allowance has to be made for the possibility of other small quantities of arsenic being received at the same time from more than one source of food and drink, and susceptible people have to be considered. And as regards diagnosis, it should be observed that notwithstanding the greater attention which has been given to the subject of chronic arsenical poisoning in consequence of the recent epidemic, it is to be expected that the true nature of milder forms of poisoning occurring in isolated instances will often fail to be recognised. And it is obvious that even if arsenical poisoning were suspected in such cases there is very little likelihood of the origin of the arsenic being satisfactorily traced.

39. Clinically, moreover, the effect of quite small quantities of arsenic administered over long periods along with food cannot be said to have been fully studied; evidence of marked toxicity may be absent, but yet the arsenic may have unrecognised effects upon nutrition.

40. In the experiments to which we have above referred, Professor Delépine found that the rat, an animal which is less susceptible, weight for weight, than man, to a fatal dose of arsenic, appeared to be injured by the continuous ingestion of liquid containing as little arsenic even as $\frac{1}{140}$ th grain per gallon. As the result of his experimental investigations, and of a general study of the subject, he was led to conclude that continuous daily ingestion of $\frac{1}{100}$ th grain of arsenic along with beer or food may be prejudicial to the human subject.

41. Looking to these various considerations, we adhere to the view expressed in our First Report, that it would be unwise to express an opinion that any quantity of arsenic, however small, is to be regarded as admissible in any articles of food, and we think it should be the aim of the food manufacturer to exclude arsenic altogether from his products.

Appx. 16, p. 190.

Delépine, 10,400.

PART II.

THE SUGGESTED RELATION BETWEEN THE DISEASE
"BERI-BERI" AND ARSENICAL POISONING.

42. Dr. Ronald Ross and other medical observers have laid stress upon the similarity between the symptoms of poisoning observed in the 1900 epidemic and those of beri-beri, a disease mainly characterised by peripheral neuritis, which is met with in certain tropical countries. Although the etiology of beri-beri is not at present understood, certain facts regarding its occurrence indicate that the disease may be due to the presence in particular articles of diet of a poison which has a toxic action on nerve tissue, and it has been suggested that beri-beri may prove to be due to contamination of food by arsenic.

Vol. I., Index, "Beri-beri."
Vol. II., do. do.

43. A few data tending to support this suggestion were supplied to us by Dr. Ross and Dr. Reynolds in the earlier stages of our inquiry. More recently, however, investigations into the question of arsenic have been made in countries where beri-beri is prevalent, particularly in the Federated Malay States, and, although we are not in a position to state how far the results of these inquiries may be accepted as conclusive, we understand that they have not established the existence of any relation between tropical beri-beri and arsenical poisoning.

44. Cases diagnosed as "beri-beri," and considered to be identical with the disease met with in tropical countries, occur from time to time among sailors arriving at English ports. Those attacked are usually either Indians or Lascars on steamships coming from Eastern ports where beri-beri is common, or Scandinavians* on sailing ships arriving, at the end of long voyages, from many parts of the world. We decided to utilise as far as possible the limited opportunities of inquiry which were thus available, and accordingly in September 1901 we invited the Medical Officers of Health of certain English Port Sanitary Districts to supply us with information regarding cases of ship-borne "beri-beri" which came to their notice, and to collect and forward samples of foods from such vessels, which we arranged to have tested for arsenic in Dr. McGowan's laboratory. With the assistance of Dr. Herbert Williams (Port of London), Dr. C. Bullmore (Port of Falmouth) and other Port Medical Officers of Health, we obtained particulars of 21 vessels arriving between September 1901 and October 1902, on which beri-beri had occurred during the voyage, and various food samples from 14 of these vessels were examined for arsenic. A detailed account of the information thus obtained is given in Appendix No. 31 to our Minutes. *Appx. 31, p. 334.* In a few instances the results gave some ground for inference that the beri-beri cases inquired into had lately been taking arsenic along with their food. Thus the hair of one or two of the patients contained noteworthy amounts of arsenic, while small quantities of arsenic were found in several samples of dried fish—an important article in the diet of sailors on Scandinavian sailing ships. But when such clinical, etiological, and chemical data as we have been able to collect are considered as a whole, they cannot be said to support the view that cases of "beri-beri" met with on ships arriving at home ports are essentially attributable to poisoning by arsenic.

* Professor V. Uchermann has kindly sent us the report of a Committee lately appointed by the Norwegian Government to inquire into the subject of beri-beri (Kristiania, 1902). This report gives further evidence of present difficulties in determining the cause of the "beri-beri" which occurs among Scandinavian sailors; it affords little information on the question of the possible relation between the disease and arsenic.

PART III.

TESTS FOR ARSENIC IN FOOD AND SUBSTANCES USED
IN THE PREPARATION OR MANUFACTURE OF FOOD.

45. The evidence which had been received at the date of our First Report showed that there existed then a very considerable diversity of opinion as to the relative value of different methods of estimating small quantities of arsenic in beer and in other foods. Many instances were reported to us in which discordant results had been obtained when identical samples were examined by different analysts and by different methods; and brewers, who were the food manufacturers principally concerned, made complaint of the position of uncertainty and difficulty in which they were consequently placed.

Since that date we have received reports of a large amount of work on the subject which has been undertaken by many chemists.

The substances examined with reference to tests have been numerous and varied. They comprise beer, malt, sugars, and various other foods and organic substances liable to contain arsenic; fuels; and chemical substances used in connection with food preparation.

46. We would refer to the valuable evidence received from a number of eminent chemists which appears in our Minutes and which gives details of the methods of examination which these analysts have studied and adopted, and also to a report received from Dr. G. McGowan (Appendix 22 of our Minutes) on the methods employed at his laboratory in testing various food samples for the Commission.

In addition to this evidence from individual analysts, we have received the Final Report of the Committee appointed by the Manchester Brewers' Association, dated May 11th 1901 (Appendix 19); and the Report of the Joint Committee appointed in March 1901 by the Societies of Public Analysts and Chemical Industry, with Mr. Hehner as chairman. This Committee made a careful investigation of the Marsh-Berzelius method, and presented a Report early in 1902, which was subsequently discussed at a joint meeting of the two Societies (Appendix 20).

As part of the action taken by the Board of Inland Revenue in pursuance of the recommendation in paragraph 34 of our First Report, a Departmental Committee was appointed in January 1902, with Professor Thorpe as chairman, to prescribe tests for arsenic in beer and brewing materials. Their Report was presented to us by Sir Henry Primrose in April of this year (Appendix 21).

47. We are now in a position to review the information obtained from these various sources under the following heads:—Estimation of arsenic by comparison of mirrors obtained by the Marsh-Berzelius method with zinc and acid; Estimation by comparison of mirrors obtained electrolytically; Estimation by other quantitative methods.

COMPARISON OF MIRRORS OBTAINED BY THE MARSH-BERZELIUS METHOD.

48. The evidence shows that it is now recognised that a satisfactory estimation of the arsenic in a given substance can be made by comparing mirrors obtained by the Marsh-Berzelius method, after the substance examined has been subjected to appropriate treatment by which any arsenic present is obtained in a solution suitable for the proper application of the test.

This method has lately been investigated in much greater detail than formerly, and certain new and important points have been

Vol. I., Index, "Tests."
Stevenson, 2475.
Salamon, 1318-29, 1524-8.
Scudder, 4268-330.
C. Brown, 6759, 6790-830.
Hooper, 7777-906.
Hehner, 7907-8057.
Vol. II., Index "Tests."
Thomson, 9654-815.
Fairley, 9878-87.
Salamon, 9969, 10,036.
Hehner, 10,094-225.
Chapman, 10,226-372.
Ling, 10,451-708.
Thorpe, 11,654-737.
Allen, 11,974-80.
McGowan and Finlow,
Appx. 22, p. 220.

Appx. 19, p. 201.

Appx. 20, p. 206.

Appx. 21, p. 208.

worked out. It is, for instance, now recognised as essential, not only to obtain zinc and acid which are free from traces of arsenic and to verify this freedom by control experiments, but also to see that the zinc used is "sensitive," and will permit all the arsenic in the solution to be evolved as arseniuretted hydrogen. Another matter brought out by recent investigation is that the presence in the solution of certain metals, notably iron, is liable to retard, or entirely to prevent, the evolution of arseniuretted hydrogen, and thus may seriously affect the estimation.

Thomson, 9750-4.
Fairley, 9882-7.
Hehner, 10,129.
Chapman, 10,236, 10,239
Ling, 10,646-8.
Thorpe, 11,666.
Appx. 22, p. 221.
Appx. 22, p. 227.

49. Chemists now appear to be in general agreement as to these and other sources of error which it is necessary to avoid, and as to the essentials to be regarded in estimating arsenic by this test.

50. The proceedings recommended by the various Committees and witnesses vary in many points of detail: for example, in the steps taken to obtain satisfactory zinc and acid, in the size of the generating flask, in the quantity of the reagents employed, and in the methods to be adopted to secure that the mirrors are satisfactorily deposited. We do not attempt to pronounce for or against particular modifications in the application of the Marsh-Berzelius method which are preferred by one or another analyst. We are satisfied that careful analysts who estimate arsenic by this method can obtain results sufficiently exact and comparable for practical purposes, although the details of their procedures may differ.

Were it possible to secure for the future the uniform adoption by analysts of one and the same method with the same detail in all respects, the determinations would become still more closely comparable, with obvious advantage. The work of the Committees and chemists to which we have above referred, and in particular the important recommendations of the Board of Inland Revenue Departmental Committee as to tests for arsenic in various substances used in the preparation of beer, materially advance this object, but do not lead to the conclusion that at this stage any single detailed routine can be said to be applicable to all cases without exception.

51. General experience of this test has shown that when in the preparation of "standard" mirrors the quantities of arsenic added to the apparatus differ by amounts such as .002 milligramme, a series of mirrors can be obtained showing differences in intensity which are sufficiently distinct and constant to be utilised for comparison. If the test is applied to a solution obtained from 10 grammes of a given substance, a difference in mirrors corresponding to .002 milligramme represents .2 parts of arsenic per million in the substance taken, or .0014 ($\frac{1}{720}$ th) of a grain of arsenic per lb. If applied to 50 c.c. of a given liquid, a difference of .002 milligramme in the mirror represents .04 parts of arsenic per million in the liquid, or .0028 ($\frac{1}{360}$ th) of a grain of arsenic per gallon.

Distinctions of greater or less delicacy can of course be made (within practicable limits) by increasing or diminishing the quantity of substance taken for the purposes of the test.

52. As regards *detection* of arsenic by the Marsh-Berzelius method, the evidence shows that when various substances are taken in quantities which have been found practically convenient, the presence of arsenic will be detected when in amounts well below $\frac{1}{1000}$ th grain per pound, or (in the case of a liquid) well below $\frac{1}{300}$ th grain per gallon.

53. Witnesses have drawn our attention to the importance of making allowance for differences in personal judgment and for other factors which may introduce difficulty in the estimation of arsenic by comparison of the intensity of mirrors. We have inquired in several instances as to the extent to which estimations may be affected from this cause in the practice of analysts conversant with the process. A difference in reading corresponding to .002 milligramme of arsenic too much or too little appears to be regarded as an outside limit, on

Hehner, 10,146, 10,186-205.
Chapman, 10,369-72.
Allen, 12,040-1.
Appx. 22, p. 222.

which basis the total error in an estimation where 10 grammes of material were employed would be .0014 ($\frac{1}{720}$ th) grain per lb. too high or too low, or with 50 c.c. of liquid, .0028 ($\frac{1}{360}$ th) grain per gallon too high or too low. For practical purposes this extent of possible error can seldom be of importance: in particular instances, where close approximation is desired, the difficulty can be met by making more than one estimation, or, if need be, by repeating the experiment with a solution corresponding to a larger or smaller amount of the substance.

54. Descriptions of the various forms of *preliminary treatment* which may be applied to different substances in order that all the arsenic they contain may be brought into a condition suitable for estimation by the Marsh-Berzelius method will be found in the reports and evidence to which we have above referred.

In the case of foods and other organic substances the question of destruction of organic matter has to be considered. In unground malt, from which all the arsenic can be extracted by dilute acid, and in a few other instances, the evidence shows that a satisfactory estimation can be made without destruction of organic matter. In such cases it is desirable that comparison should be made with standards prepared by the addition of known quantities of arsenious oxide to arsenic-free specimens of the material examined.

On the other hand, it is desirable to destroy the organic matter in instances where the organic solution in the Marsh-Berzelius apparatus is liable to cause frothing, or to cause any appreciable generation of sulphuretted hydrogen, and so may interfere with the proper working of the test. Destruction is also necessary where there is reason to suspect that some or all of the arsenic may exist in the form of an organic compound, or where it is otherwise intimately combined with organic matter; *e.g.*, in hair and animal tissues, yeast, liquorice, and coal-tar colours.

In the case of brewers' wort the organic matter interferes with the test to an extent which may cause small quantities of arsenic to escape observation, and hence should first be destroyed.

In the case of beer we have already stated (Part I., paragraph 28) that there is no evidence that arsenic when present in beer exists as a compound of cacodyl or its homologues. Some chemical witnesses have expressed the opinion that arsenic in beer may enter into combination in some way not understood with albuminous or other organic substances. The evidence upon this point, however, is altogether incomplete. We have evidence that comparable results have been obtained by analysts who destroyed organic matter in beer and by others who added the beer to the Marsh-Berzelius apparatus direct. On the other hand, some beers have not been found to yield all the arsenic they contain unless the organic matter is first destroyed. Mr. Hehner informed us that when using the direct method he came to the conclusion that when beer is kept for some months it may gradually lose the arsenic it contains, whereas he afterwards found that no difference in respect of arsenic could be detected between beer before and after keeping, if the organic matter was in each instance destroyed before testing.

Several chemists who have given close attention to the subject prefer to destroy the organic matter in beer as a matter of routine before employing the Marsh-Berzelius test; and the Departmental Committee of the Board of Inland Revenue also recommend this course. It appears to us that this plan should be uniformly adopted.

55. In most substances it has been found satisfactory to destroy the organic matter, either by one or another "acid" method, or by a "basic" method, in which the substance is burnt along with lime or magnesia sufficient to retain the arsenic.

56. In the case of *fuel*, where examination is made with the object of separately estimating the arsenic which is volatilised during the

C. Brown, 6832.
Hooper, 7796.
Hehner, 8043-56.
Thomson, 9688, 9755-7.
Fairley, 9887. V33B.
Hehner, 10,132-8, 10,179-85.
Chapman, 10,262-75.
Appx. 20, p. 207.
Appx. 21, p. 213.
Appx. 22, p. 223.
Appx. 27, p. 277.
Appx. 31, p. 351.

Hehner, 10,214-25.

combustion of the fuel and that which remains behind in the ash, two methods of preliminary treatment have been described to us.

The first consists of burning the fuel with lime or other base in order that all the arsenic present may be retained in the residue after combustion is complete, and also of estimating the arsenic which remains when the fuel is burnt alone: the difference between the two estimations representing "volatile" arsenic. The application of this method to fuel was described to us by Mr. Ling, and its principle has been adopted by Dr. McGowan in testing for the Commission the series of samples from anthracite collieries to which reference is made below. *Ling, 10,451-76.
Appx. 20, p. 207.*

Dr. McGowan found that in solutions obtained from the residues after combustion, the presence of iron interfered materially with estimations of arsenic by the Marsh-Berzelius test. In Appendix 23 he has given (along with Mr. R. B. Floris) a detailed account of the procedures adopted in order to eliminate this and other sources of error. *Para. 94, below.
Appx. 23, p. 227.*

The second method, more recently described in the report of the Departmental Committee (Appendix 21), consists in burning the fuel in a current of oxygen, collecting the arsenic which is volatilised in an absorption apparatus containing dilute sulphuric acid; and subsequently estimating the volatile arsenic obtained in this solution, and also the arsenic left behind in the ash. For this purpose, the ash, after suitable treatment, is distilled with hydrochloric acid and the distillate is used for the Marsh-Berzelius or electrolytic test. *Appx. 21, p. 210.*

COMPARISON OF MIRRORS OBTAINED BY THE ELECTROLYTIC METHOD.

57. The method of evolving arseniuretted hydrogen by electrolysis, without the use of zinc and acid, has recently been carefully studied by the Departmental Committee, whose Report gives an account of the apparatus designed in the Government Laboratory for the purpose, and which can be applied wherever an electric current of sufficient intensity is available. *Appx. 21, p. 208.*

The Committee have found that when the current is suitably controlled and other precautions which they describe are taken, the evolution of arseniuretted hydrogen takes place with great uniformity, and the resulting mirrors, though similar and comparable to those obtained by the zinc and acid method which they also describe, have the advantage of being more definite and thus allow for greater exactness in estimation.

58. Moreover, in examining in this way a variety of substances connected with brewing, they have found that the nature of the material associated with the arsenic exercises no inhibitory effect on the formation and evolution of arseniuretted hydrogen. They are satisfied that beer and worts may be added directly to the electrolytic apparatus without previous destruction of organic matter.

59. We understand that this method is now adopted at the Government Laboratory in preference to the Marsh-Berzelius test with the use of zinc and acid, and now that the results of the Committee's work are in the hands of chemists, wide experience of the working of the electrolytic method which they recommend may soon be looked for.

OTHER QUANTITATIVE METHODS.

60. Our evidence shows that some chemists prefer, or at least have in the past preferred, to estimate small quantities of arsenic by other means than comparison of mirrors; *e.g.*, gravimetrically, by using a large quantity of the substance and weighing sulphide of arsenic finally obtained from it; by extracting the arsenic by means of copper gauze; by the Gutzeit test; or by the Reinsch test with subsequent examination and comparison of sublimate. *C. Brown, 6759-830.
Hooper, 7777-96.
Jones, 1793-803.
Kirkby, 3630-85.
Delepine, 4928, 5208,
10,375-80.*

61. In view, however, of the general use by analysts of methods involving comparison of mirrors, to which greater precision has been given by the work of the last few years, and of the great importance of comparability of results, it seems essential that chemists applying other methods for routine purposes to the examination of food and substances used in food preparation should be aware of the extent to which their determinations correspond with or differ from those made by comparison of mirrors.

Moulton, 9939, 9957-63.

Solemon 9969-73, 10,036-47.

Appx. 5, p. 323.

62. Mr. Gordon Salamon and others have urged that, apart from quantitative estimations by comparison of mirrors, it is convenient for the brewer or maltster to use for ordinary working purposes a form of the Reinsch test, simpler in application but sufficient to show for practical purposes whether or not a material quantity of arsenic is present in beer, malt, or brewing ingredients. We fully recognise that the Reinsch test, as recommended by the Expert Committee appointed by the Manchester Brewers, served a most useful purpose at the time of the 1900 epidemic, when it was necessary to test rapidly a large number of beers and brewing ingredients in order to eliminate at once those which were highly contaminated by arsenic. But we are now satisfied that the use of the Reinsch test entails considerable risk of missing quantities of arsenic which, though small, are not to be regarded as negligible. It is noteworthy in this connection that at one of the breweries at Halifax which supplied arsenical beer in 1902 the beer had been systematically tested by the Reinsch method and only negative results had been reported. Having regard to the better understanding which now exists of the precautions required in using more delicate tests involving the comparison of mirrors, and to the greater ease and certainty with which those tests can now be applied, we think that the use of the Reinsch test for the purpose above indicated must be considered unnecessary, and that it may even be misleading.

PART IV.

WAYS IN WHICH FOODS ARE LIABLE TO BECOME
CONTAMINATED BY ARSENIC.

63. We have received much useful evidence from witnesses as to the risks of arsenical contamination which arise in the manufacture of sundry foods and substances used in food preparation. In particular, we have obtained from chemists and manufacturers detailed accounts of processes employed in the preparation of glucose, "invert" sugar, malt, and other substances which are used in brewing; and also of sulphuric acid, in relation to arsenic.

In investigating the large subject of the liability of foods other than beer to contain arsenic, we sought in the first instance the co-operation of Public Analysts in England and Wales, and by circular letter in June 1901 we invited them to supply information as to food substances in which arsenic had been looked for or detected, or which, by reason of their method of preparation, may become contaminated by arsenic in the absence of suitable precautions. Valuable information in these directions was supplied by a large number of public analysts. Shortly afterwards we engaged the services of Mr. H. Hammond Smith, M.R.C.S., to make inquiry on our behalf from representative food manufacturers, and to visit their works. In October 1902, Mr. Hammond Smith, on completion of these inquiries, made a detailed report upon his investigations into the whole subject, which appears as Appendix 24 to our minutes.

In prosecuting his inquiries, and in preparing his report, Mr. Smith made full use of the data which had been supplied by witnesses and public analysts, and also of various suggestions as to points for inquiry which had come before the Commission in other ways. In numerous instances he obtained samples which it seemed desirable to have examined for arsenic, and we arranged that these samples should be tested in Dr. McGowan's laboratory. Dr. McGowan in Appendix 25 shows in a series of tables the results of analysis of the substances thus submitted to him and the method of testing for arsenic which he adopted in each case.

In November 1902 we took further evidence from manufacturers of food other than beer.

64. The information collected in these ways deserves the careful consideration of food manufacturers and others concerned. For the purposes of our Report, it will suffice to draw attention, first, to certain principal food ingredients and other substances which, in the absence of precautions, have been shown to involve risk of arsenical contamination of articles of food, and secondly, to certain finished foods which in consequence are liable to such contamination.

PRINCIPAL INGREDIENTS OF FOOD, OR SUBSTANCES USED IN FOOD
PREPARATION, WHICH ARE LIABLE TO CONTAIN ARSENIC.

SULPHURIC ACID.

65. Sulphuric acid is the first and most important of the substances to be considered. Directly or indirectly this acid is used, sometimes in relatively large amount, in the preparation of a variety of foods.

The greater part of the sulphuric acid used for manufacturing and general purposes in this country is obtained by roasting pyrites ores, imported mainly from Spain and Portugal. Such ores, notably those from certain mines, contain large proportions of arsenic. Acid thus manufactured, unless subjected to a de-arsenication process, is in-

Dixon, 3415, 3461.
Davis, 6381, 6394-400.

Davis, 6399-420, 6509-16.

Stevenson, 2398.
Howell, 11, 229.

Tattersall, 12.
Dixon, 3430-60.
Salamon, 1264.
C. Brown, 6709-36.

Vol. I., Index. "Sulphuric Acid."
Vol. II. *do.*

Morris, 4672.
Davis, 6407.
Appr. 24, p. 230, note.

Davis, 6381, 6466, 6493.

Appr. 20, p. 206.
Appr. 22, p. 220.
Davis, 6496.

variably arsenical. At works where a de-arsenication process is carried out, the system of manufacture usually followed necessitates the production, in addition to the de-arsenicated acid, of an acid, derived from the Glover tower, which habitually contains a high proportion of arsenic. This, however, is not the case where the acid is prepared by synthetic processes which have been introduced in recent years.

The sulphuric acid ("B.O.V.") supplied in 1900 by Messrs. Nicholson & Sons to Messrs. Bostock & Co. was contaminated by arsenic to an exceptional and enormous degree. As much arsenic as 1.45 and 1.9 of arsenious oxide per cent. has been estimated in certain samples of this acid.

66. Chemical and other technical witnesses are agreed that de-arsenicating processes when thoroughly and uniformly applied at works where acid is obtained from pyrites, produce an acid which is practically free from arsenic. Such de-arsenicated acid, of the quality and specific gravity usually supplied commercially, when tested by a delicate test shows either no arsenic at all, or else only minute amounts of arsenic. Proportions of arsenic as high as from 2 to 3 parts per million (approximately $\frac{1}{70}$ th to $\frac{1}{50}$ th grain per pound of acid) can only occur if the de-arsenication is not properly carried out.

67. Sulphuric acid is also manufactured from natural brimstone, from "recovered sulphur," and from the "spent oxide" of gas works. Where these materials are used the degree to which the acid is liable to become contaminated by arsenic is comparatively small, and usually such acids are not subjected to de-arsenication processes. Our evidence shows that sulphuric acids prepared in these ways can be obtained which are at least as pure as regards arsenic as de-arsenicated pyrites acid; nevertheless they must not be assumed without analysis to be free from arsenic.

68. The difference in price between arsenical sulphuric acid prepared from pyrites without purification, and sulphuric acid which is practically free from arsenic (whether de-arsenicated pyrites acid, or acid prepared in other ways) is comparatively small—*e.g.*, something less than 5s. on an acid sold at 2*l.* a ton—and in connection with articles of food or substances which may be used in the preparation of food this difference can seldom be of any account to the food manufacturer.

HYDROCHLORIC ACID.

69. Commercial hydrochloric acid, as is well known, frequently contains arsenic, which has been derived from the use of arsenical sulphuric acid in its manufacture. Where the sulphuric acid used has contained much arsenic the hydrochloric acid may be highly contaminated. Thus Mr. G. E. Davis reported 1.12 grammes of arsenious oxide per litre in a recent specimen of hydrochloric acid which had been prepared from sulphuric acid, the product of an arsenical pyrites.

70. Hydrochloric acid free from minute quantities of arsenic appears to be less easily attainable commercially than is the case with sulphuric acid. The liability of hydrochloric acid to be arsenical is, however, relatively small in the case of acids prepared by "cylinder" or other processes in which special care is taken to employ sulphuric acid which is pure in respect of arsenic.

GLUCOSE.

71. The glucose used by brewers is usually "solid." It is manufactured on a large scale at factories in Great Britain, and a considerable quantity is also imported from America and Germany. The glucose used for confectionery, syrups, and other food purposes is generally "liquid," and is almost always imported. Solid and liquid glucose alike are liable to contain arsenic derived from sulphuric or

hydrochloric acid, which are used in varying proportions (*e.g.*, from 2 to 6 per cent.) in the "conversion" process by which the glucose is manufactured from starch. In view of the circumstances of the 1900 epidemic it is unnecessary to insist upon the high degree of arsenical contamination of glucose which may be brought about by neglect of precautions regarding the quality of the acid used. Solid glucose manufactured by Bostock & Co. in 1900 in several instances was ascertained to contain as much arsenic as 3 grains per pound, and even larger proportions of arsenic were estimated in a few specimens.

Salamon, 1406.
Garton, 60 3-64.
Francis, 7355.
Wahl, 7431-2.

Tattersall, 15.
Jones, 1768.
C. Brown, 6700.
Hooper, 7869.

72. If due attention is given to the purity of the chemical substances employed, there appears to be no difficulty in producing glucose which is free from arsenic. As stated in our first report, glucose manufacturers in general were aware of the necessity of guarding against arsenic before the 1900 epidemic, and took precautions with this object. Since then, as was to be expected, such precautions have been generally strengthened. Instances have been reported to us in which specimens of glucose, both of home and foreign manufacture, and not coming from Bostock's, have been found to contain from $\frac{1}{40}$ th to $\frac{1}{12}$ th grain of arsenic per pound (3.5 to 11.9 parts per million), and some of those arsenical specimens apparently have been of recent manufacture. But such instances have been few, and we have evidence that glucose supplied to brewers has lately been almost uniformly satisfactory as regards arsenic. Some 500 specimens of such glucose have been tested at the Government Laboratory since the issue of our first report. In the majority no arsenic was detected; and in the remainder, with only two exceptions, the amount of arsenic present was below $\frac{1}{250}$ th grain per pound (.57 parts per million).

Ling, 10,576, 10,632.
Primrose, 11,847 (Table II.)
Appx. 24, p. 235.

Primrose, 11,847.

"INVERT" SUGAR.

73. The "invert" sugar which is used by brewers (and sometimes also in the preparation of cider and of certain fermented "non-intoxicating" beverages) is manufactured in this country on a considerable scale by subjecting cane or beet sugar to an "inversion" process in which sulphuric acid is added to the sugar. At the works of Bostock and Co., about 3 per cent. of sulphuric acid was used for this purpose, and the "invert" sugar produced in 1900 contained large amounts of arsenic (estimated in different specimens from 1.4 to 4.3 grains per pound).

Tattersall, 20.
C. Brown, 6709.
Hooper, 7869.
Delepine, Appx. 12, p. 349.

74. Contamination of "invert" sugar by arsenic is avoidable by the exercise of due care on the part of the manufacturer to secure that a pure acid is used in the process. We have evidence that a large number of samples of "invert" sugar have been recently examined for arsenic at the Government Laboratory with negative results. Other samples also recently tested there have shown only small quantities of arsenic, in nearly all cases below $\frac{1}{250}$ th grain per pound.

Primrose, 11,847.

GLYCERINE.

75. Glycerine is of importance in view of its use in various articles of confectionery, and also as an ingredient of certain kinds of cake.

Glycerine which has been prepared by distillation of the crude glycerine derived from soap makers' lyes may contain considerable amounts of arsenic derived mainly from the hydrochloric acid used in the manufacture of the crude product.

Appx. 24, pp. 233, 255.

For pharmaceutical or food purposes the arsenic can be removed from glycerine so prepared by suitable processes at the glycerine distillery, and glycerine which has been thoroughly de-arsenicated, as also glycerine which has been prepared by hydrolysis, habitually shows either no trace of arsenic, or else any arsenic present is too small in amount to be detected by the Gutzeit test which the British Pharmacopœia, 1898, directs to be applied to pharmacopœial glycerine. It should however be observed that doubts have been expressed as to the sufficiency of this pharmacopœial test. It has

C. Brown, p. 255.
H. Smith, 10,916-8.

been stated that this test may fail to detect quantities of arsenic which though comparatively small are nevertheless easily avoidable and also that the quantity of arsenic which would transgress the limit defined by this test is somewhat uncertain. We have been in communication with the Pharmacopœial Committee of the General Medical Council with reference to this matter, and we understand that the sufficiency of the official test for arsenic in glycerine is now under their consideration.

Appx. 24, p. 233.

76. Glycerine supplied for pharmaceutical and domestic purposes has occasionally been found to contain much arsenic: for example, 1 grain or more of arsenic per pound (143 parts per million), and exceptionally even 3 or 4 grains per pound, have been reported by different analysts within recent years. We have evidence from public analysts and others that shortly after the 1900 epidemic a number of samples of British and foreign made glycerine sold for pharmaceutical purposes were tested for arsenic, and that objectionable quantities of arsenic, though smaller than those above mentioned, were found in certain of these samples.

COLOURING MATTERS.

Mineral Colouring Matters.

Hehner, 8015-8.

Pronk, 11,402, 11,443.

Honell, 11,250-3.

Hehner, 10,210, Appx. 27, p. 277.

77. The principal mineral colouring matters used in food are oxide of iron, and substances sold under various names ("Bole Armenia" and the like), which consist mainly of oxide of iron. Owing to the method by which oxide of iron is prepared such colouring matters habitually contain arsenic in considerable amount. The reported instances include a sample of "Bole Armenia" on sale at one of the London Stores in 1902, which was found by Dr. McGowan to contain $\frac{4}{5}$ ths grain of arsenic per pound, and a sample of oxide of iron used as an addition to cocoa, which in June last was reported by Mr. Hehner to be "immensely arsenical."

Appx. 24, p. 234

Appx. 25, p. 268.

Appx. 27, p. 277.

Oxide of manganese, another mineral colouring matter sometimes used in food, has also been found to be contaminated by arsenic.*

Hehner, 10,210.

Coal-tar Colouring Matters.

78. Arsenic has been used in the process of manufacture of certain coal-tar colours, particularly magenta dyes, and such colours have been found to be highly contaminated by arsenic. But this method of preparation of magenta dyes appears to be seldom employed at the present day. A variety of coal-tar colours are however liable to contain arsenic, which probably has been derived from the sulphuric acid used in their preparation. Instances in which the quantity of arsenic detected in coal tar colours used by sweet manufacturers has been as much as, or more than, $\frac{1}{2}$ grain per pound, have been reported to us.

Pronk, 11,373.

Appx. 24, p. 234.

Pronk, 11367, 11,378-83.

Hehner, Appx. 27, p. 277.

Appx. 25, p. 268-9.

Appx. 22, p. 225.

Caramel.

79. Caramel, which is used to colour and flavour a large number of foods, including some kinds of beer, may contain arsenic as a result of its method of preparation from glucose or cane sugar. The origin of the arsenic has been attributed mainly to the use of impure alkaline carbonates in its manufacture. Considerable quantities of arsenic (in some instances more than $\frac{1}{4}$ grain per pound) have been reported in a number of samples of caramel. On the other hand caramel which is free from arsenic may readily be obtained commercially: numerous analyses have been reported to us which show that caramel samples have shown no arsenic when delicate tests have been applied.

Vol. I., Index "Caramel."

Vol. II., do.

* Coloured salts of arsenic, such as Scheele's Green or Emerald Green, are so notoriously poisonous that it may be assumed that they are never used in food, and are avoided by manufacturers of toys or other articles which may be given to children or used about the house. The use of emerald green to colour wax tapers or candles appears to us objectionable and dangerous. Mr. William Thomson informed us last year that he had detected as much as 5.32 *per cent.* of arsenious oxide in green tapers thus coloured.

L. 999, 11,769-72.

PHOSPHORIC ACID AND PHOSPHATES.

80. Phosphoric acid and phosphates are used in the preparation of a variety of food substances: for example phosphoric acid is used in sugar refining and in mineral waters, and phosphates in baking powders. Commercial phosphoric acid and commercial phosphates, both of British and foreign manufacture, are liable to contain arsenic, largely derived from sulphuric acid used in their preparation. These substances, as sold by druggists and as supplied to food manufacturers, have frequently been found to contain arsenic in notable amount.

Appx. 24, p. 231-2.

Stevenson, 2381-6.
Davis, 6455.
Appx. 24, p. 231.
Appx. 25, p. 265.

81. There appears, however, to be little difficulty in obtaining commercially phosphoric acid and phosphates which are comparatively pure as regards arsenic. Thus one manufacturer who tests for arsenic systematically, informed us that he habitually obtains phosphoric acid containing less arsenic than 2 parts per million ($\frac{1}{2}$ nd grain per pound), and we have evidence that since attention was directed to the subject in 1900 the phosphates sold to druggists and for food purposes have been generally purer in respect of arsenic than was formerly the case.

Lyle, 11,033, 11,042-4
11,095.

BORIC ACID AND BORATES.

82. Boric acid and borates are largely used in preserving meat and fish, and are also often added in considerable amount to butter, milk, and other foods. Many analysts have reported to us the detection of arsenic in commercial borax and boric acid to the extent of $\frac{1}{10}$ th grain per pound (14 parts per million), or thereabouts; in some samples of borax over $\frac{1}{3}$ rd of a grain of arsenic in the pound has been reported.

Stevenson, 2358-60.
Appx. 24, p. 233.

83. "Chemically pure" borax and boric acid, free from arsenic, are prepared by suitable processes of purification. In practice, however, the borax and boric acid which are used as food preservatives are of the cheaper "commercial," not the "chemically pure" variety.

OTHER CHEMICAL SUBSTANCES USED IN FOOD.

84. Considerable quantities of arsenic have been determined in certain samples of beer "regenerators" and "neutralisers," consisting mainly of alkaline carbonates used for the treatment of beer which is becoming sour; in samples of materials used for hardening brewing water, which consist largely of sulphates, carbonates, and chlorides; in "Kainit," a natural earth used for the same purpose; and in a few samples of "malto-peptones," yeast foods which consist essentially of soluble phosphates associated with nitrogenous matter. There appears, however, to be little difficulty in obtaining purity in the case of these and other chemical substances used in connection with brewing. A large number of such substances have been examined in the Government Laboratory since the issue of our First Report. In many, no arsenic has been detected; and in most of the remaining samples the arsenic present has been estimated at less than $\frac{1}{250}$ th grain per pound, or in the case of liquids, less than $\frac{1}{100}$ th grain per gallon.

Primrose, 11,847, Table II.
11,869-73.

Briant, 7224.

Primrose, 11,847, Table I.

85. The liability of tartaric and citric acids to contain arsenic, in consequence of the use in their manufacture of large quantities of sulphuric acid, has been frequently mentioned in evidence, and we have been informed that small amounts of arsenic have been detected in certain samples, including some of foreign manufacture. We have evidence that care is taken by firms manufacturing these substances to obtain sulphuric acid which is free from arsenic, and that the stringent precautions against contamination by lead which are usually taken would also remove arsenic if present.

Kirkby, 3704.
Davis, 6423.
Thompson, 9669.
Howell, 11,218.
Appx. 24, p. 232.
Appx. 25, p. 265-6.

86. Acetic acid, sulphurous acid, and bisulphites—used in the preparation of a variety of food substances—have also in a few instances been reported to contain small amounts of arsenic.

MALT.

87. The liability of malt to be contaminated by arsenic was first recognised after the cause of the 1900 epidemic had been ascertained. Considerable amounts of arsenic have been reported by different witnesses to have been found in malt: as much as $\frac{1}{20}$ th grain and exceptionally even $\frac{1}{6}$ th grain of arsenic per pound have been detected in some samples, while numerous analyses have been reported to us in which the malt has been found to contain from $\frac{1}{100}$ th to $\frac{1}{30}$ th of a grain of arsenic per pound. As stated in Part I. of this Report, the presence of notable quantities of arsenic in malt has been confirmed by analyses of beer in which it seems certain that no arsenic was introduced otherwise than by way of the malt used.

88. The question of arsenic in malt has lately received close attention from brewers and maltsters, and malts as a whole have in consequence improved in this respect. All our evidence goes to show that it is now commercially practicable to produce malt which either may be considered free from arsenic, or in which the amount of arsenic present is certainly less than $\frac{1}{250}$ th grain per pound (.57 parts per million), and that most of the malt prepared during the past two years has been of this character.

89. The exclusion of small quantities of arsenic from malt has proved a matter of considerable difficulty, and consequently we refer to it here at somewhat greater length than in the case of other ingredients of food.

90. The coal or coke used for malt drying always contains arsenic. When the fuel is burnt on the fire of an ordinary malt kiln, part of the arsenic is volatilised, and much of the arsenious oxide which is formed becomes condensed or deposited on the internal surface of the kiln, on the malt floor, or in the malt. Part of the arsenic remains behind in the ash in combination (as arseniate) with basic matter contained in the fuel. Some of this ash, carried up by a strong draught, may become deposited in the malt and so add to the quantity of arsenic which the latter contains.

91. We have received a considerable amount of evidence from maltsters and chemists as to methods which have been tried and adopted in order to obtain malt which is free from arsenic; and we now briefly refer to the ways in which it has been found that access of arsenic to malt may be obviated or diminished.

Malting without Access of Products of Combustion.

92. It is evident that if malt is dried by means of heated air, without any admixture of the products of combustion, no difficulty with regard to arsenic can arise. As stated in our First Report, we have evidence from both brewers and maltsters that according to general belief it is essential that the products of combustion should pass through the malt in order that it may possess a flavour which is necessary for beer. We have not received sufficient experimental evidence to enable us to give a satisfactory answer to the question whether flavour is in fact dependent on the fumes from the fire, and if so, whether, in order to obtain the flavour desired, it is necessary to pass the products of combustion through the grain during the whole of the time in which it is drying on the kiln.

The expense involved in altering the structure of ordinary malt kilns in order that the malt may be dried solely by means of heated air would be very considerable, and this consideration itself may be expected to prevent any immediate general adoption of this means of

Appx. 24, p. 233.

Estecourt, 3982.
C. Brown, 6709-10, 6768.
Hooper, 7880-2.
H. Smith, 8650.
Thomson, 9669, 9691.
Fairley, 9855.

H. Smith, 8665.
Worsick, 9441.
Thomson, 9758.
Fairley, 9853.
Salamon, 9994.
Chapman, 10,282.
Ling, 10,684.
Primrose, 11,847.

Thorpe, 11,696.
Ling, 10,570-3, 10,704.
Beaven, 10,805-11.

Vol. I., Index, "Malt."
Thomson, 9697-8.
Salamon, 9980.
Ling, 10,606-12.
Beaven, 10,735-70.

Salamon, 9980.

producing malt which is free from arsenic. Since our first Report was published, however, we have received descriptions and specifications of various processes for drying malt on the kiln without access of fumes from the fire. These and other methods no doubt require to be tried on a considerable working scale at English maltings before sufficient experience can be gained of their advantages or disadvantages from the point of view of the cost involved, and of the extent to which they meet the requirements of the brewer, and the demands of the public taste. But so far as the exclusion of arsenic and the wider choice of fuel are concerned, the advantage is unquestionable, and it is obviously important that processes of malting without the products of combustion should in future receive careful attention from brewers and maltsters who are about to erect new malt kilns.

Selection of Fuel.

93. As stated in Part I. of this Report, it has long been the custom in many parts of England and Wales to use nothing but anthracite for drying malt. Elsewhere, especially in Yorkshire and Midland maltings, oven coke and gas coke were often the principal fuels used up to 1901—largely no doubt because their local abundance and the remoteness of the anthracite collieries combined to make the difference in cost considerable. In that year the liability of malt to be arsenical became generally understood, and it was speedily recognised that the most arsenical malts were those which had been dried over gas coke, whereas anthracite-dried malts, as a rule, were comparatively little contaminated by arsenic. As a result the use of gas coke for malt drying has been largely discontinued. The use of oven coke also has been discontinued to a considerable extent. The exclusive use of anthracite for malting was strongly recommended to brewers and maltsters by the Expert Committee appointed by the Manchester Brewers' Association, in their final Report issued in May, 1901.

94. Although at the date of our first Report we had received an abundance of evidence which showed the objectionable character of certain gas cokes and the relative advantages of using anthracite, we were without information as to the extent to which arsenic may occur in anthracites used for malting. Few examinations of such anthracites appeared to have been made; moreover, satisfactory methods of estimating small quantities of arsenic in fuels had still to be worked out. Since that date we have instituted inquiries into the subject and have received further evidence. In Appendix No. 30 will be found a series of reports relating to arsenic in coals obtained from the anthracitic region of South Wales from which the great bulk of anthracite used for malting in this country is obtained. This Appendix embodies information supplied to us by Mr. A. Strahan, of the Geological Survey, regarding the appearance and geological correspondence of the seams of anthracite worked at various collieries which he visited for the purpose of our inquiry, the distribution and nature of the "impurities" associated with anthracite in certain of these seams, and the practice of the collieries visited in respect of the removal of impurities from the coal which they supply to maltsters.

From these collieries a large number of samples were carefully collected for the Commission by Mr. S. Warren Price (Lecturer on Mining at University College, Cardiff), who subsequently furnished a report showing in detail the steps which he took to secure that these samples were comparable and properly representative. They comprised a series of anthracites as prepared at the colliery for sale to maltsters, a second series obtained underground from the different seams of anthracite worked at the various collieries, and a third series representing characteristic "impurities" associated with anthracite, which are capable of being removed from the coal either by the miner underground or by hand-picking at the surface.

All the samples thus obtained were tested for arsenic in Dr. McGowan's laboratory by a method of analysis (based on that of

Tomson, 3100-6, 3161.
Deakin, 3881.
O'Sullivan, 5743.
Earp, 7111, 7171.
H. Smith, 8724.
Thompson, 9058.
Buckley, 9293, 9368-73.
Worsick, 9425.
Thomson, 9692.
Appx. 19, p. 204.

Ling, 10,446-536.
Thomson, 9784-9.
Salamon, 9984, 10,059.
Chapman, 10,353-67.

Appx. 30, pp. 286-325.

Appx. 23, p. 227.

Messrs. Newlands and Ling) which he describes in detail (Appendix 23), and which he had found to give accurate results.

Appx. 30, p. 290.

95. These reports on malting anthracite deserve attention from brewers and maltsters and also from colliery proprietors and managers. They afford a considerable collection of comparable data regarding representative specimens, which should prove valuable for reference in connection with future chemical examinations of anthracites for arsenic; while the indications which have been obtained by these investigations afford useful guidance on various matters which require attention in the selection of anthracite for malting purposes.

Appx. 30, p. 288.

96. In particular they show the great importance as regards arsenic of thoroughly and systematically removing all "impurities" from anthracite used in malting. The amount of arsenic found in the large number of different samples of "clean" anthracite was relatively small—in almost all cases it was below 10 parts per million ($\cdot 07$ grain per pound)—whereas many of the "impurities" associated with the anthracite contained comparatively large quantities of arsenic. The impurities in question comprised not only yellow pyrites, or "brasses," which are generally known to be liable to contain much arsenic, but also certain samples of impure coal consisting largely of shale, and well-marked bands of black, granular, impure coal, which show little or no "brassy" pyrites. As a rule satisfactory removal of the above impurities, where present, is effected readily enough if suitable appliances are used and proper supervision is exercised at the colliery. In certain circumstances, however—for example, where black granular bands are distributed intermittently throughout the thickness of a seam of anthracite—the matter is one of greater difficulty and requires the exercise of a corresponding amount of care.

Appx. 30, pp. 303, 309.

Vol. I., Index, "Fuels."
Fairley, 9824.
Ling, 10,536.
Appx. 19, p. 203.
Appx. 30, p. 320.

97. *Gas cokes* have been found in many instances to contain large quantities of arsenic. Thus the proportions of arsenic determined by Dr. McGowan in samples of coke taken this year from three gas works in Yorkshire, each of which used formerly to supply maltsters, were respectively 125, 144 and 200 parts per million ($0\cdot 9$, $1\cdot 0$ and $1\cdot 4$ grains per pound). Brewers and maltsters as a whole appear to have found little difficulty in abandoning the use of gas coke in 1901, and having regard to the quantities of arsenic found in certain specimens, and to the arsenical contamination of malt which has resulted from the use of gas coke, we are of opinion that this fuel should not be used by maltsters unless in connection with special methods of treatment to which we refer below, and then only after careful selection of the coke.

Ling, 10,536, 10,542-3.
Appx. 30, p. 320.

98. We have received a number of analyses of *oven cokes*. Some have contained only small proportions of arsenic, such as those ordinarily met with in clean anthracite; while in others arsenic has been present in considerable quantity, *e.g.*, between 30 and 50 parts per million ($0\cdot 2$ and $0\cdot 35$ grains per pound). The extent to which oven coke may contain arsenic is determined mainly by the nature of the coking coal from which it is derived and by the amount of care taken, by washing or otherwise, to free the coal from pyrites and other impurities before it is put into the coking oven. The fact of the fuel being oven coke is not in itself a sufficient guarantee of its purity as regards arsenic; the selection by the maltster of satisfactory oven coke will depend upon sufficient information being obtained as to its origin and manufacture, and upon the exercise of the control afforded by frequent analysis of samples.

Ling, 10,451, 10,671-2.

99. Mr. Ling and others have laid stress upon the importance of determining not only the "total" arsenic contained in samples of malting fuel, but also the proportion of "volatile" arsenic which escapes when the fuel is burnt under laboratory conditions, and the proportion of "fixed" arsenic which remains behind in the ash. Methods by which "fixed" and "volatile" arsenic may be estimated

are described in detail in our Minutes, including the form of test recently recommended by the Board of Inland Revenue Departmental Committee, and that which was adopted by Dr. McGowan in analysing fuel samples for the Commission.

Ling, 10,451.
Appx. 21, pp. 210, 214.
Appx. 23, p. 227.

In the case of anthracite, and also of coke, the proportion of "volatile" to "total" arsenic appears to vary considerably in different specimens tested under identical conditions. In general it has been found that the proportion of arsenic volatilised under experimental conditions of combustion is less in the case of cokes than in the case of anthracite. The experimental evidence which we have received, however, is not sufficient to determine the extent to which particular processes of estimating "volatile" arsenic in the laboratory can be relied upon to furnish an index of the proportion of arsenic which will become volatilised when the fuel is burnt, under varying conditions, on the fire of the malt kiln.

Appx. 30, p. 289
Ling, 10,536.
Thorpe, 11,701

Appx. 30, pp. 290, 325.

Treatment of Fuel.

100. Processes have lately been devised for utilising the property possessed by lime, in common with other basic substances, of absorbing and "fixing" arsenic. We have received evidence as to a practice suggested by Mr. Newlands and applicable particularly to coke, in which the fuel, before being put into the kiln fire, is intimately mixed with the base by the addition of milk of lime. Mr. Beaven has also described an arrangement by which lumps of limestone are placed at the outlet of the kiln furnace. He claims that the fumes from the fire, in passing over the surfaces of heated lime thus provided, lose practically all the arsenic they contain.

Ling, 10,555-69, 10,589-95,
10,660.
Buckley, 9316.

Beaven, Appx. 18, p. 199.

Cleansing of Kilns.

101. Sweepings from the inner walls, girders, dispersing plates, and other parts of malt kilns have been found to contain surprisingly large quantities of arsenic. The liability of malt to become arsenical is greatly increased when such dust is allowed to accumulate on any of these surfaces, either below or above the malt floor. For safety it is imperative that the interior of kilns should be thoroughly cleansed, not only when they are first taken into use at the beginning of the malting season, but also at frequent intervals as the season progresses.

Fairley, 9824, 9859, 9905,
9920.

Salamon, 9988, 9996.
Thompson, 8954, 9017.
H. Smith, 8753.
Buckley, 9413.
Worsick, 9473.
Ling, 10,570, 10,688.
Appx. 30, Part VI.

Construction of Kilns.

102. Malt kilns differ greatly in their construction; for example, in the height of the malting floor above the fire, in the number of malting floors, in the construction of the furnace, and in many other ways. There is no doubt that, other things being equal, the structure of some kilns tends to greater risk of arsenical contamination than that of others. We have evidence that maltsters in dealing with the question of arsenic in malt have in some cases found advantage in making various structural alterations in their kilns. Thus, in some instances dispersing plates and screens have been provided, which serve to condense some of the arsenious oxide which has been volatilised, and also to arrest some of the dust carried up by the current of hot air from sides of the kiln or from the furnace. In other instances alterations have been made in the openings of the kiln in order that a considerable proportion of the hot air passing through the malt may be raised to the necessary temperature without contact with the fire.

Beaven, 10,709-910.

Screening and Brushing of Malt.

103. All brewers' malt is screened to separate the rootlets or culms, and in this process a certain amount of the arsenic deposited on the grain may be mechanically removed. It is important that screening should be thoroughly carried out, as it has been shown that the culms often contain relatively considerable quantities of arsenic. The brushing

Vol. I., Index, "Malt."

Vol. I., Index, "Malt."
Worsick, 9457.
Thomson, 9780.
Fairley, 9863.
Salamon, 10,018.

machinery which is in use at a good many maltings and breweries is capable of removing a considerable proportion of the arsenic from arsenical malt, especially where the brushing is repeated several times. It is, however, obviously preferable to take steps to prevent the access of arsenic to malt, rather than to rely on any subsequent process for removing arsenic after it has become deposited on the grain.

HOPS.

Vol. I., Index, "Hops."
Appx. 19, p. 202.
Thomson, 9669.
Primrose, 11,847.

104. Hops are exposed to the products of combustion of fuel during their drying on the kiln, and it has also been suggested that they may become contaminated through the use of impure sulphur (on the kiln or as an insecticide) and possibly in other ways.

It is the practice of hop driers to employ anthracite, and not coke, for burning in the kiln, and if suitable care is exercised in the selection of fuel the risk of hops becoming contaminated is evidently small. The quantities of arsenic which have been reported to us as having been detected in hops have in all cases been minute.

FINISHED FOODS WHICH ARE LIABLE TO ARSENICAL CONTAMINATION.

105. The following are the chief foods, or kinds of foods, which our evidence has shown to be liable to arsenical contamination, through the use of the above ingredients or in other ways, in the absence of sufficient precautions.

BEER.

106. The liability of beer to be contaminated by arsenic arises mainly through the use in brewing of arsenical glucose, invert sugar, and malt, or by the addition of arsenical invert sugar or glucose as "priming" after the wort has been fermented. The degree of contamination which may arise in these ways is abundantly illustrated in our evidence.

Since the 1900 epidemic and the appointment of this Commission close attention has been given by brewers to the exclusion of arsenic from these and other substances used in brewing, and various precautions have been extensively adopted with the object of eliminating all risk of arsenical contamination of beer. We have referred in the first part of this report to evidence that, notwithstanding the general adoption of these precautions beer has been occasionally met with in which notable amounts of arsenic (for example $\frac{1}{20}$ th or $\frac{1}{30}$ th grain per gallon) have been found. But such instances at the present time may be considered quite unusual. We are satisfied from the evidence received during the later part of our enquiry that much of the beer sent out at the present time from breweries in this country may be regarded as free from arsenic, and that arsenic, where detected, is usually in minute amount. All the chemical witnesses from whom we have recently had evidence (including responsible chemical advisers of breweries) have been agreed that it is commercially practicable to produce beer which uniformly shows less arsenic than $\frac{1}{100}$ th grain per gallon, and in which as a rule any arsenic present is in much smaller proportion than this.

GOLDEN SYRUP AND TREACLE.

107. In the preparation of these substances from cane or beet sugar it is customary to "invert" the sugar to a greater or less degree by the addition of mineral acids, in order to prevent crystallization. About two per cent. of sulphuric acid is frequently used for this purpose. The high degree of arsenical contamination which may result if the sulphuric acid used is arsenical, has been shown in the case of the "Table Syrups" which Messrs. Bostock and Co. began to manufacture in 1900 (paragraph 7). Contamination of syrups of this kind by arsenic can be readily prevented by the exercise of strict care in the selection and testing of the sulphuric acid used, and by attention also to the purity of other substances used in the manufacture (such as hydrochloric or phosphoric acids), which are liable to contain arsenic.

Vol. I., Index, "Priming."

cf. para. 21, above.
Thomson, 9669, 9758.
Fairley, 9852, 9923.
Primrose, 11,847.

Salamon, 9966.
Behner, 10,169-78.
Chapman, 10,279.
Primrose, 11,847.
Allen, 11,973.

Appx. 24, p. 233.
Lyle, 11,028-160.

H. Smith, 10971.

108. The evidence which we have received regarding the manufacture of this class of syrup shows that before the 1900 epidemic, precautions were adopted by manufacturers in this country to ensure that the mineral acids employed were satisfactory as regards arsenic, and that since the epidemic additional safeguards have been provided with satisfactory results. One important manufacturer of "golden syrup," who gave evidence as to the precautions adopted in his factory, informed us that as a result of numerous analyses it had been found that if any arsenic was detected in the syrup, the amount was invariably minute; for example "nothing approaching one part of arsenic per million" ($\frac{1}{143}$ rd grain per pound) had ever been discovered in any sample of the syrup. *Lyle, 11,114-5.*

FOODS CONTAINING GLUCOSE.

109. Glucose is an ingredient of a large variety of food substances. Certain syrups sold as "table syrup," "amber syrup," and the like, consist largely of liquid glucose. Jams and marmalade frequently contain from 5 to 10 per cent. of glucose, and sometimes larger amounts. Glucose may be mixed with honey, or used as a basis for the manufacture of "artificial honey." Certain kinds of sweets and confectionery, again, consist largely of glucose. *Appx. 24, pp. 238-243. Walker, 11,321-2.*

110. A large number of these foods, particularly sweets and confectionery, were tested for arsenic by public analysts shortly after the 1900 epidemic, and it is satisfactory that arsenic was detected in hardly any of them. Having regard, however, to the evidence which we have received as to glucose, and to reported instances in which material quantities of arsenic have been determined in samples of imported liquid glucose of the kind commonly used by confectioners, it is evident that foods of this class, in the absence of sufficient analytical control, are subject to risk of serious contamination by arsenic. We have evidence that since attention has been drawn to the subject certain manufacturers have taken steps to obtain guarantees of purity of the glucose which they purchase from the manufacturer, importer, or middleman, and that others have from time to time caused samples of the glucose to be tested for arsenic. On the other hand, certain manufacturers whose products contain large proportions of glucose appear to have considered it unnecessary to take any steps to assure themselves by analysis that their glucose was satisfactory in respect of arsenic, notwithstanding the circumstances of the epidemic of 1900. *Appx. 24, p. 236. Walker, 11,308-31.*

VINEGAR.

111. At some vinegar factories the principal material from which vinegar is made consists of raw grain (rice or maize) which has undergone a process of "conversion" in which sulphuric acid is used in much the same way as in the manufacture of glucose. Our inquiries show that at vinegar factories where "converted" grain is used, precautions have been taken since the 1900 epidemic to obtain acid which is satisfactory as to arsenic. *Appx. 24, p. 246.*

Other substances liable to contain arsenic may be used in vinegar manufacture, for example, malt and sour beer.

DEMERARA SUGAR.

112. We have evidence that small quantities of arsenic—exceptionally as much as $\frac{1}{50}$ th and $\frac{1}{60}$ th grain per pound—have been detected in samples of "Demerara" sugar coming from the West Indies. *Appx. 24, p. 239.*

It has been suggested that the presence of arsenic in such samples is attributable to the use in their manufacture of arsenical phosphoric acid, or of chloride of tin (a salt which may contain arsenic as an impurity), which is frequently used in the West Indies to give a characteristic "bloom" and colour to the sugar.

113. Other samples of brown sugar, both from the West Indies and from English refineries, when tested by a delicate test capable of detecting $\frac{1}{1000}$ th grain per pound, have been found free, or practically free, from arsenic.

Lyle, 11,069.
Appx. 25, p. 264.

FOODS, OTHER THAN BEER, PREPARED FROM MALT AND YEAST.

114. Various extracts of malt, "maltine" and the like, are manufactured for sale to invalids, and are also used by bakers. Prepared foods under a variety of names have lately come on the market, and are being extensively used, which are recommended to the public by the manufacturers on the ground that they will provide a meal without cooking or other preparation. In these foods malt is frequently an important ingredient. Malt also enters largely into the preparation of certain "infant foods."

Appx. 24, p. 245.

The number of cases reported to us in which foods prepared from malt have been tested for arsenic has been comparatively small. Arsenic has been recognised to be present in certain samples, but others, including four examined by Dr. McGowan, have been found free from arsenic when subjected to delicate tests. Mr. Hammond Smith has reported to us that certain British manufacturers whom he visited have lately controlled the purity of the malt used by frequent analysis, or at least by obtaining a guarantee as to arsenic from the maltster. Most of the foods in question, however, are manufactured abroad, mainly in America, and we have not been able to obtain satisfactory information as to the nature of the precautions, if any, which are adopted by American maltsters or manufacturers of malt foods.

Appx. 24, p. 245.
Primrose, 11,847, Table II.
Appx. 25, p. 262.

Appx. 26, p. 276.
H. Smith, 10,935.

115. Yeast takes up arsenic when grown in an arsenical wort. The utilisation of yeast as an article of human food appears to have been receiving attention in recent years, and foods have been manufactured in which yeast is a principal ingredient. We have received evidence from the manufacturer of a food termed "Carnos," made from yeast and malt culms obtained from a Yorkshire brewery, that this preparation was frequently found to contain $\frac{1}{30}$ th grain of arsenic to the pound after the epidemic of 1900, notwithstanding the adoption of a series of precautions to prevent arsenical contamination. In four different samples of "Carnos" Dr. McGowan found from $\frac{1}{25}$ th to $\frac{1}{6}$ th grain of arsenic per pound. This food was not at any time largely sold, and we understand that its manufacture has now ceased altogether.

Appx. 24, p. 244.
Appx. 25, p. 262.
Overbeck, 11,260-307.

FOODS CONTAINING GLYCERINE.

116. Glycerine is sometimes used in the manufacture of cakes to the extent of one to three per cent. of the materials employed, in order to keep them moist. A few meat extracts contain a large proportion of glycerine, and it is also used in some kinds of confectionery. In these foods material quantities of arsenic might be introduced through the use of impure glycerine. Our evidence shows that some food manufacturers using glycerine stipulate that it should be "pure" or "suitable for food purposes," or that it should be of Pharmacopœial quality. It appears, however, that the liability of glycerine to contain arsenic is not known to many manufacturers who use this substance in the preparation of food.

Appx. 24, p. 243.
Palmer, 11,456-79.
Appx. 24, pp. 240, 244.

H. Smith, 10,923.

FOODS IN WHICH CERTAIN COLOURING MATTERS AND PRESERVATIVES ARE USED.

117. Bole Armenia and other mineral colouring matters consisting mainly of oxide of iron are frequently added in considerable proportion in the preparation of a variety of foods, for example sausages, anchovy preparations, cocoa, and certain kinds of sweets. Material quantities of arsenic may be contributed to these substances in this way. Thus Mr. Hehner, in June of this year, informed us that he had estimated

Appx. 24, p. 247.
Appx. 27, p. 277.

approximately $\frac{1}{20}$ th or $\frac{1}{25}$ th grain of arsenic per pound in a "chocolate powder" largely sold in London at a cheap price, which had been contaminated by arsenic through the use of oxide of iron. He also estimated the arsenic in certain sweets, similarly coloured, at $\frac{1}{30}$ th grain per pound. Arsenical contamination of various coloured foods may also arise from the use of arsenical coal tar colours or arsenical caramel. *cf. para. 78 above.*

118. The addition of large quantities of boron preservatives to foods likewise entails risk of their becoming contaminated by arsenic, and arsenic detected in certain foods has in some instances been traced to these preservatives. *Appx. 24, p. 248.*

MISCELLANEOUS.

119. Instances have been reported to us in which the presence of small quantities of arsenic have been determined in gelatine (in consequence of the use of impure sulphuric acid in its manufacture) and in liquorice sweets (possibly through the addition of impure glucose, or to the use of sulphuric acid or glycerine in the manufacture of the liquorice stick) *Appx. 24, p. 239.*
Thomson, 9794.
Appx. 24, p. 241.

120. We have made inquiries concerning foods which are dried or otherwise prepared by exposure to the fumes of coal or coke. In many localities and factories gas coke is used to dry bloaters and hams. But these substances are exposed to the fumes to a small extent by comparison with malt; moreover the surface exposed is relatively small, and the arsenic would be deposited mainly on the outside skin, which is not eaten. The arsenical contamination which might arise in these cases appears to us inconsiderable, and such experimental evidence as we have received supports this view. Similarly, no appreciable contamination seems likely to occur in the case of food grilled over an open fire. *Appx. 24, pp. 249, 250.*
Appx. 25, pp. 270-3.

121. On the other hand chicory should be specially mentioned, as the process of drying chicory roots is similar to that of drying malt, and where coke is used on the drying kiln (as is said to be usual in Belgium and the North of France), the chicory is liable to become contaminated by arsenic. Our information as to analyses of chicory for arsenic is limited to a few specimens, in which the place of manufacture and the nature of the fuel used was not ascertained. Two of these samples showed about $\frac{1}{100}$ th grain of arsenic per pound. *Appx. 24, p. 250.*
Thomson, 9790.
H. Smith, 10,995.

INQUIRIES AS TO RISKS FROM ARSENIC, THE RESULTS OF WHICH HAVE BEEN NEGATIVE.

122. Reference will be found in our evidence and in Mr. Hammond Smith's report to certain ways in which it has been suggested that risk of arsenical contamination of food may arise, but where no evidence of such risk has been obtained on inquiry.

Contamination of Cereals or Roots grown on Arsenical Soil.

123. Manuring with commercial superphosphates, which commonly contain considerable amounts of arsenic, has been supposed to entail risk of contamination of cereals or roots. Dr. J. A. Voelcker, Consulting Chemist of the Royal Agricultural Society of England, this year reported to us the results of a valuable series of experiments on this question. At the Society's experimental farm at Woburn, barley and swedes were grown on several quarter-acre plots which had been respectively manured with superphosphate containing no arsenic, manured with superphosphates containing various known proportions of arsenic, and left unmanured. In the ripe crop, minute amounts of arsenic were detected in all cases in the barley straw and (in the one case examined) in the leaves of the swedes. But no arsenic was detected by a delicate test capable of detecting $\frac{1}{10000}$ th grain per lb. (.14 parts per million) in any sample of the barley grain, or of the bulbs of the swedes. In the previous year, 1902, we also received an interesting account from *Stevenson, 2309-13.*
Appx. 19, p. 202.
Fairley, 9824.
Salamon, 9999, 10,016.
Voelcker, 12,078-163.

Angell, 8463-8657.

Mr. A. Angell, of experiments which he and Mr. A. F. Angell had made in the same direction. As a result of these experiments, which were carried out on a smaller scale and with a greater variety of vegetables than those at Woburn, Mr. Angell reported that he had been unable to detect arsenic in the ripe grain or in the fruit or seed of any one of a considerable number of plants grown on soil previously manured with a specially arsenicated superphosphate.

Contamination of Spirits by the addition of Mineral Acid.

Appx. 24, p. 231.
Appx. 28, p. 278.

124. It has often been stated to be a practice of publicans, particularly in the poorest neighbourhoods of London, to add mineral acid to gin or whisky, to give them a "nip" appreciated by a certain class of customers, and the possibility of arsenic being introduced in this way has been suggested in connection with the occurrence of alcoholic neuritis among spirit drinkers. Last year, on the recommendation of the London County Council, a large number of samples of spirits obtained from public-houses in poorer parts of London were submitted by Borough Councils to their public analysts for examination for mineral acid and for arsenic. The results were uniformly negative.

Use of Arsenic in fattening Poultry.

Appx. 24, p. 251.
Appx. 25, p. 273.
H. Smith, 10,997-11,007.

125. It has been suggested that if arsenic is administered to poultry to fatten them for market (as is said sometimes to be the case) the flesh of the birds may become contaminated. Certain experiments on which Mr. Hammond Smith and Dr. McGowan report, however, negative the suggestion of risk arising in this way.

In view of the evidence of the elimination of arsenic in man by the hair, it is of interest to mention that in these experiments a considerable proportion of arsenic was detected in the feathers of fowls which had been given small doses of arsenic for several weeks.

Use of Arsenic in the Enamel of Cooking Utensils.

126. Arsenic was formerly employed as an ingredient of the enamel of saucepans and other cooking utensils, and it has been shown that liquids boiled in such utensils may take up considerable quantities of arsenic.

H. Smith, 11,008.
Appx. 29, pp. 281-5.

Statements having been made that cooking utensils in which arsenic is contained in the enamel are still occasionally sold, we took steps to obtain a series of saucepans and other specimens of enamelled hollow-ware from a number of different sources. Twenty-six of these specimens, coming from at least 14 different factories, British and foreign, were examined by Dr. McGowan, who reported that arsenic had not been used as an ingredient of the enamel in any instance.

Certain "Prepared Foods."

H. Smith, 10,935.
Appx. 24.

127. In a few instances we have made inquiries, with negative results, concerning the process of manufacture of certain prepared foods, for example "meat extracts," prepared cereal foods, and "milk foods," with a view to ascertain whether their mode of manufacture or the nature of their ingredients involve any risk of contamination by arsenic. It must, however, be remembered that foods of this kind are as a rule sold in bottles, tins, or packets, under registered trade names, which give no indication of the nature or mode of preparation of the food substances which they contain, and it is often difficult, and in the case of imported foods it is in present circumstances practically impossible, to obtain accurate information on these points.

PART V.

PRECAUTIONS WHICH SHOULD BE TAKEN BY MANUFACTURERS TO EXCLUDE ARSENIC FROM FOODS.

128. It will appear from the foregoing Part (IV.) of this Report that in many instances manufacturers of foods, and of substances used in the preparation of foods, which are liable to be contaminated by arsenic, have realized the necessity of taking effectual steps to prevent the presence of arsenic in their products. We do not doubt that manufacturers, as a whole, are desirous of doing whatever may be needful to secure that the articles which they supply for the food of the public should be of satisfactory purity, and we believe that absence of adequate precautions as regards arsenic, where occurring, is largely due, not so much to carelessness (and still less to desire for profit, for little pecuniary advantage could in any case be derived from the use of inferior ingredients containing arsenic), as to want of appreciation of the risks involved. We think it well, therefore, to state what we consider, in the light of the information obtained from our inquiries, to be the duty of the manufacturer of foods or food ingredients when liability to arsenical contamination arises, and this apart altogether from the recommendations which we make below as to improved administration to secure better means of official control in regard of the purity of food.

INGREDIENTS OF FOOD, AND SUBSTANCES USED IN THE PREPARATION OF FOOD, WHICH ARE LIABLE TO CONTAIN ARSENIC.

129. We have evidence that before the epidemic of 1900, manufacturers of certain of the ingredients of food noted in Part IV. were in the habit of taking steps to guard against risk from arsenic. The epidemic, and the inquiries of this Commission, have led in numerous instances to precautions being strengthened; for example, glucose, brewing sugars, phosphates, and other food ingredients have recently, as a whole, been much purer as regards arsenic than formerly. Moreover, precautions have now been adopted in the case of malt and other substances, which previously had not been recognized as liable to arsenical contamination.

130. It is satisfactory and reassuring that it has been found commercially practicable to produce for food purposes sulphuric acid, phosphoric acid, glycerine, glucose, "invert" sugar, caramel, and malt, either yielding no arsenic when tests of considerable delicacy are applied, or else not more than such traces of arsenic as are indicated in the foregoing part of this Report. We are of opinion that all manufacturers of these substances should take steps to obtain uniformly degrees of purity at least as high as those which our evidence has shown to be at present commercially attainable, and that they should always be alive to improvements which tend to eliminate even traces of arsenic.

Cf. paras 66, 81, 75, 72, 74, 79, 88, above.

131. It is essential that manufacturers of the above substances, as also of other ingredients of food which are liable to arsenical contamination, should frequently test their products for arsenic, and should keep for their own guidance a systematic record of the results of the testing adopted. Tests used should show not merely that arsenic if present does not transgress some arbitrary standard of purity which the manufacturer finds it convenient or necessary to adopt, but they should be of sufficient delicacy to enable minute amounts of arsenic to be detected and estimated, so that he may be able to know what degree of success his precautions are affording. For this purpose it

*Garton 6237-46.
Francis, 7386-9.
H. Smith, 8706.
Lyle, 11,132.
Appx. 24, p. 238.*

Hehner, 10,151-4

Cf. paras. 45-62, above.

Thomson, 9699.
Salamon, 10,060-6.
Chapman, 10,337-53.
Ling, 10,631-2.
Appx. 24, p. 238.

will ordinarily be best that estimations should be made by comparison of mirrors, obtained either by the zinc and acid method or electrolytically. Application of these methods to various substances has been greatly facilitated by recent work to which we have above alluded (Part. III), and we consider them not only the more accurate, but also little if at all more troublesome in practical application than other and less delicate tests. It is, of course, essential in the case of every substance that a uniform and satisfactory method of obtaining a representative sample should be adopted.

132. We regard it as essential that any guarantee as to arsenic supplied by the manufacturer of an ingredient of food should be given with full knowledge of the amount of arsenic which, if present, would be detected by the test which he employs, and of the significance, in terms of approximate quantity, of any minute proportions of arsenic which he cannot be certain of excluding by the precautions which he adopts.

133. It may be asked whether a manufacturer is justified in giving to his customers a guarantee as to "freedom from arsenic" in his product, if he knows that minute amounts of arsenic (for example $\frac{1}{500}$ th grain per pound in glucose or malt) may occasionally be detected when a delicate test such as the Marsh-Berzelius is applied. We think such a guarantee may reasonably and properly be given, provided always that the manufacturer attaches, and is prepared to inform his customers that he attaches, a definite significance to his statement—in other words, that he can state a definite proportion of arsenic which he has satisfied himself that his product certainly does not contain—and provided also that he does his best to keep out arsenic altogether irrespective of the guaranteed limit.

134. The guarantee might, for example, take the form of a statement that the ingredient has been freed from arsenic as far as is practicable, and that any arsenic present in no case exceeds a stated proportion. We think that no substance should be used as an ingredient of food which contains a larger proportion of arsenic than $\frac{1}{100}$ th grain per lb. or, in the case of solutions $\frac{1}{100}$ grain per gallon: and it will be seen on reference to the ingredients detailed in Part IV. that in many cases (particularly glucose, see paragraph 72, and malt, see paragraph 88) more stringent limits are now attainable commercially and should be insisted upon. The form of guarantee of "freedom from arsenic" which we think a manufacturer should not employ is one which is arrived at merely by the use of a crude test, of insufficient delicacy, and with an unknown or uncertain significance in terms of the quantity of arsenic which it will detect.

135. It is important also that guarantees as regards arsenic should not be given unless tests are applied systematically and with sufficient frequency. Giving such guarantees should not be allowed to degenerate into a perfunctory routine.

136. In respect of ingredients of food, and substances used in the preparation of food, the value and practical utility of guarantees as to "freedom from arsenic" in the above sense would be increased if such guarantees were given on a uniform basis with reference to official "standards," which should define for particular substances the proportions of arsenic, judged by a defined test, which should be regarded as inadmissible. We are satisfied that such standards are needed for the use of manufacturers and users of the substances in question. We make recommendations below as to the means by which they should be established.

137. Certain of the substances here in question are also drugs included in the British Pharmacopœia. At present the tests for arsenic which the British Pharmacopœia directs to be employed are qualitative, and the quantity of substance to which the qualitative tests are to be applied is in nearly every case undefined. The Pharmacopœial

Vol. I, Index,
"Guarantees."
H. Smith, 8794.
Moulton, 9936-9.
Hegner, 10,147-65.
Chapman, 10,326.
Lyle, 11,134-5.
Howell, 11,194-209, 11,248.
Walker, 11,218-9.
Pronk, 11,453.
Palmer, 11,494-6.
Primrose, 11,959-60.

Vol. I, Index,
"Official control."
Thomson, 9809-15.
Moulton, 9936-9.
Salamon, 10,007-8.
H. Smith, 10,939-49.
Thorpe, 11,720-1.
Allen, 12,073-4.
Appx. 24, p. 254.

Cf. paras. 173-7, below.

H. Smith, 10,912-8.

Committee of the General Medical Council has now under consideration the question of revising the pharmacopœial tests for arsenic, with the object of giving them a quantitative value, and of adding to the list of drugs which are required to be tested for arsenic*; and they have forwarded to the Commission a preliminary report by Professor Dunstan, who is investigating the subject. It may be anticipated that when this revision has been completed, manufacturers and users of substances for food purposes, which are also pharmacopœial preparations, will find advantage in adopting the pharmacopœial standards in respect of arsenic.

138. The manufacturer of chemical substances used in the preparation of food (for example, mineral acids, glycerine or colouring matters) frequently prepares the same substances for sundry manufacturing purposes unconnected with food in which the presence of small quantities of arsenic is a matter of relatively less importance. Often indeed supplying substances for use in the preparation of food constitutes only a small part of his business. Wherever practicable in such cases, it is desirable that the manufacturer should take steps to ensure that his product, whether sold for food purposes or not, should uniformly be satisfactory as regards arsenic. Where, however, it is considered necessary to manufacture products which may be arsenical, as well as better qualities of the same substances which are free from arsenic, it is particularly important that the manufacturer should take all practicable steps to ascertain whether the substances he supplies are required for the preparation of food or its ingredients. Dealers or middlemen selling to food manufacturers should make it their business to ascertain from the maker of the food ingredient that the article to be supplied is suitable for food purposes.

Davis, 6410.
Wahl, 7429.
Pronk, 11,431-3.

139. In this connection we would draw attention to the much too prevalent custom of selling chemical substances to food manufacturers under misleading or ambiguous trade names. Instances have been given to us for example in which the sulphuric acid manufacturer has supplied pyrites acid under the name of "brimstone acid," and we understand from the statements which has been made to us on behalf of Messrs. Nicholson & Co. that loose usage of the trade terms for sulphuric acid—"stone acid," "brimstone acid" and the like—is one of the reasons which the firm advances in explanation of the circumstances which led to their supplying arsenical acid to Messrs. Bostock & Co. We have evidence that solutions or preparations of phosphoric acid are largely sold to mineral water makers and to bakers for use in place of the better known, and more expensive, citric and tartaric acids. If these substances were sold avowedly as solutions or preparations of phosphoric acid recommended for use in substitution for citric or tartaric acid, there would be little reason for objection. But we regard it as dishonest that the manufacturer should describe his phosphoric acid preparation by such a name as "liquid tartaric acid," without any intimation of its real nature. Where merely "fancy" names which do not pretend to have any chemical significance are adopted, the manufacturer is less open to criticism than in the case above quoted. It appears to us, however, that the responsibility of the manufacturer for the purity of his products—and this not only in regard to arsenic—is greatly enhanced when he sells chemical substances to food manufacturers under such names.

Tattersall, 21-6.
Davis, 6472-7.
Francis, 7338-41, 7370-4.

Appx. 24, p. 232.
Howell, 11,200-1.

140. It is important that manufacturers of colouring matters used for food purposes should give more attention to excluding arsenic than appears to have been the case hitherto. As shown above, some coal-tar colours used in food have been found to contain considerable quantities of arsenic, and strict precautions should be taken by all colour makers to see that such colours are not supplied for food purposes. Mineral colours (oxide of iron, "Bole Armenia," and

Cf. paras. 77-8, 117, above.

* For example, no test for arsenic is at present required in the case of the reduced iron (ferrum redactum) of the British Pharmacopœia. (This drug may contain much arsenic; as much as 1 per cent. has been reported to us in one instance.)

Reynolds, 8456-62.

oxide of manganese in particular) frequently contain large quantities of arsenic. These colours are used in much larger proportion in foods than are coal-tar pigments, and mainly for purposes which we cannot consider desirable (for example, for colouring cheap sausages and some preparations of cocoa and chocolate). We think that, even if free from arsenic, they should not be used in food; their liability to be arsenical affords an additional and important reason for their being abandoned.

Cf. para. 112, above.

141. Chloride of tin is used to give a colour and "bloom" to West India sugars, and no doubt some of the arsenic which has been detected in these sugars has been introduced in this way. Chloride of tin appears to us an objectionable and unnecessary addition to sugar, and we are of opinion that it should no longer be used.

f. para. 118, above.

142. Similarly with regard to boron preservatives in commercial use. Their employment in large and uncertain quantities, besides being itself objectionable, entails risk of arsenical contamination.

Appx. 24, p. 240.

143. An isolated instance of the use of lanoline in the preparation of food as a substitute for cocoa-butter has come under our notice. In view of the liability of wool grease to be contaminated by arsenic from sheep-dip, lanoline seems to be an objectionable substance to use in the preparation of food stuffs.

FINISHED FOODS LIABLE TO CONTAIN ARSENIC.

144. The manufacturer who takes the responsibility of using substances liable to contain arsenic in the preparation of the food which he supplies to the public can guard against arsenical contamination:

(1) By obtaining adequate assurance from the vendor (*see* paragraphs 132-5) that the ingredients which he purchases are satisfactory in respect of arsenic (having regard to the limits which the evidence before the Commission shows to be already practicable), and by taking care that their intended use for food purposes is known to the vendor.

(2) By testing any ingredients which he purchases or himself prepares.

How far in practice sufficient security can be obtained by adopting the first of these precautions, without the second, must depend on the circumstances of particular cases. It can hardly be expected, for example, nor can it be considered essential, that a baker in a small way of business who uses a phosphatic baking powder should frequently submit such a powder to a chemist to be analysed for arsenic. In such a case the food manufacturer must needs place his main reliance upon the care which he has reason to believe is taken by the maker of the ingredient, and upon guarantees of purity which are supplied to him. There are, on the other hand, certain foods as to which we are satisfied from the evidence that it is essential for the food manufacturer to frequently and systematically test his ingredients for arsenic, no matter what may be the nature of the guarantees or of the assurances which he receives from their makers. These are beer, foods in which a considerable proportion of glucose is used (*e.g.*, table syrups, jams, marmalade, and certain forms of confectionery), or which, like glucose, are prepared by the use of a relatively large quantity of sulphuric or hydrochloric acid (*e.g.*, treacle, golden syrup, vinegar made from converted raw grain), and foods, the principal basis of which is malt or yeast, or into which glycerine enters in any considerable proportion.

Cf. para. 131, above.

145. In these cases, also, we think that the tests applied, alike to the ingredients and to the finished product, should be delicate, and should enable minute quantities of arsenic, if present, to be detected and estimated so that the manufacturer may know the degree of success which he is attaining in excluding arsenic. Records should be kept of the results of the system of testing adopted.

PART VI.

PRESENT MEANS OF OFFICIAL CONTROL OVER PURITY OF FOOD, IN RELATION TO ARSENIC.

146. Under this heading we summarise the effect of the evidence which we have obtained from various witnesses regarding the means of official control over the purity of food which is at present available :—

(a) to prevent ingredients of food which are contaminated by arsenic from being used by the food manufacturer.

(b) to prevent finished food products contaminated by arsenic from being sold to the public.

CONTROL OVER THE MANUFACTURE OF FOOD OR OF FOOD INGREDIENTS.

147. The existing machinery of public health administration provides little if any system of official control over the proceedings of manufacturers of food or of food ingredients. The fact that on certain premises food or its ingredients are made or prepared, does not of itself entitle the officials of County, Borough, Urban or Rural District Councils, who are charged with the local administration of the Acts relating to public health and sale of food, to enter the premises, to require information concerning processes of food manufacture, or to demand samples for analysis, with a view of ascertaining if risk of contamination by any deleterious substance arises and whether suitable precautions are taken. Similarly, an individual or a company who starts the manufacture of some new composition of food, sold under a "fancy" name, is under no obligation to satisfy the local or any other public authority that the composition and its ingredients are wholesome. There are a few instances in which local authorities possess power of control at particular places where food is manufactured: for example, the sanitary authorities of certain districts have obtained powers, under local Acts, to supervise the conditions of manufacture of ice-cream. Broadly speaking, however, the control which can be exercised becomes available only after the manufacture of the food is completed, and it is on sale to the public.

Tattersall, 296-310.
Niven, 796-803.
Hope, 1012-34.
Neech, 9224-9, 9246-51.
H. Smith, 10,931-63.
Lithiby, 11,508-12, 11,530,
11,548-83.
Allen, 12,046-7.

148. Officials of Government departments possess and exercise powers of entry into factories for specified purposes (as for example, under Factory Act, with reference to conditions affecting the health and safety of the persons employed) and their powers, in certain instances, enable them to institute inquiries into methods of food manufacture. Where margarine and margarine cheese are made, officers of the Board of Agriculture have the right to inspect any process of manufacture, take samples, and examine books showing the destination of margarine or margarine cheese sent out from the factory. With regard to articles subject to duty, various powers of inspection and sampling are conferred upon revenue officers. At breweries, Officers of Excise are in position to ascertain generally what materials are used in the preparation of beer, and, practically speaking, they are there able to take samples of any ingredient for examination in the Government Laboratory. Samples of substances intended for use as additions to beer—such as preservatives—are required to be submitted to the Board of Inland Revenue, whose sanction must be obtained before they can be used. Although similar sanction is not required before particular substances can be used in brewing, yet, by the Customs and Revenue Act of 1888 the Commissioners of the Treasury have power to prohibit, by issue of an

Sale of Food and Drugs
Act, 1899, S. 7.

Primrose, 6526-6708.
Spencer, 5356, 5433-7.
Deakin, 3899.

order published in the London Gazette, the use in the manufacture or preparation for sale of any article of excise, of any "substance or liquor of a noxious or detrimental nature," or which "being a chemical or artificial extract or product, may affect prejudicially the interests of the Revenue," and any person using the substance thus prohibited in the manufacture or preparation for sale of any article specified in the published notice is subject to penalty.

149. The main object with which these various powers have been granted to, and have been exercised by the Board of Inland Revenue, has, of course, been the protection of the Revenue. In our first Report, we considered the question of utilising the system of Government inspection which exists at breweries, to obtain safeguards against the introduction of arsenic into beer by way of its ingredients. Evidence which we received from the Chairman of the Board of Inland Revenue in April of this year, summarises the action which the Board have been able to take in this direction since our first Report was issued. We have referred above (par. 46), to the appointment of the Departmental Committee to advise with regard to official methods of testing for arsenic, and to their report. In October, 1901, the power of prohibition under the Revenue Act of 1888, which previously had been applied only to saccharin, objected to for revenue reasons, was exercised in respect of glucose and "invert" sugar containing arsenic, which were prohibited by Treasury Order. Since the issue of this Order, the Board of Inland Revenue have caused numerous samples of brewing ingredients to be taken at breweries by their officers—not only glucose and "invert" sugar to be examined with reference to the above prohibition, but also malt, caramel, hops and other substances. These, as well as a number of brewer's worts, have been tested in the Government Laboratory. Samples of brewing sugars collected at factories in this country have also been examined in the Government Laboratory, as well as imported brewing sugars which had been obtained by brewers without guarantees of their freedom from arsenic. Substances submitted for sanction as additions to beer, have been examined for arsenic, and in certain cases where beer "regenerators" and yeast foods have been found arsenical the manufacturer has either been cautioned or sanction to the use of the substance has been withheld. Brewers also have been warned in certain instances where their malt or other ingredients taken at the brewery was found to be seriously contaminated by arsenic.

First Report, paras. 26-34.
Primrose, 11,844-967.
Salamon, 9991-3.
Chapman, 10,317-48.

150. We understand that the Board of Inland Revenue have been able to utilise their official staff for the above purposes without detriment to their principal revenue duties, and that it has been found practicable at the Government Laboratory to examine samples of brewing materials to the considerable extent indicated in the evidence to which we have referred. We are of opinion that the action thus taken has been most valuable and that it should be continued in the future. It has been represented to us that in ordinary circumstances a general test of the brewers' precautions, and one which is administratively convenient, consists in applying tests for arsenic to samples of wort obtained by the Revenue Officers, and this appears to us a useful procedure for routine purposes.

CONTROL OVER FOOD ON SALE.

151. SALE OF FOOD AND DRUGS ACTS:—Under present conditions the main system of official control against the introduction of deleterious substances into food consists in the application of the Sale of Food and Drugs Acts, which empower officers of local authorities to obtain samples of foods and of food ingredients in a prescribed manner from places where they are on sale, for the purpose of analysis by the public analyst. Offences against the Acts may be dealt with by proceedings instituted by the local authority under Section 3 or Section 6 of the Sale of Food and Drugs Act of 1875. Section 3

imposes a penalty on any person who "mixes, colours, stains, or powders any article of food with any ingredient or so as to render the article injurious to health, with intent that the same may be sold in that state." Section 6 imposes a penalty on the person who "sells to the prejudice of the purchaser any article of food or any drug which is not of the nature, substance and quality of the article demanded by such purchaser," subject to certain specified reservations.

Prosecutions under the first of these sections, in respect of additions to food which are or which may be held to be deleterious are comparatively seldom instituted by authorities under the Acts. The Section would cover, no doubt, cases where a substance well known to be poisonous is purposely added to food, for example if red lead was mixed with cayenne pepper, or Scheele's green used to colour sweets. But authorities administering the Sale of Food and Drugs Acts have found that the circumstances under which this section can be utilised to deal with articles which contain ingredients liable to be harmful seldom arise, and in practice nearly all prosecutions are taken under Section 6 of the Act. Prosecutions in respect of preservatives in milk for example are usually instituted under this section for the sale of an article—milk plus preservative—not of the nature, substance and quality demanded by the purchaser.

Even in the case of foods contaminated by arsenic in such ways as we have described in Part IV. of this report, it would appear that a prosecution would in most instances have greater chance of success if taken under section 6, and this view was held almost without exception by the local authorities which decided to institute prosecutions with regard to arsenical beer in consequence of the 1900 epidemic.

152. The evidence which we have received from various official witnesses shows that the Sale of Food and Drugs Acts, as at present interpreted and administered, are unsatisfactory for the purpose of protecting the consumer against arsenic or other deleterious substances in food, mainly for the following reasons:—

153. (a) *Prosecution of Retailer.*—The offence created by Section 6 of the Act of 1875 lies in the sale of the deleterious or adulterated article. Save for certain small exceptions, (as where samples have been taken in transit to the retailer, with the latter's consent) prosecutions must be directed, not against the manufacturer, importer, or middleman, but against the retailer, who, in the great majority of such cases as we are considering, has had nothing to do with the contamination, and has seldom been in a position to ascertain that it exists. It is true that if the retailer is prosecuted, the case may be defended on his behalf by the manufacturer, but none the less the retailer is liable to be prejudiced in the eyes of his customers, and our evidence shows that local authorities are often reluctant to institute proceedings in these circumstances against a person whom they do not regard as himself culpable. The retailer can protect himself by obtaining a warranty, which will be a bar to his conviction in the case of foods which he can prove that he sold in the same state as when purchased, and where the case against the retailer fails through a successful defence of warranty, it is open to the local authority to take action subsequently against the warrantor. But the conditions which have to be complied with under the statutes, in order that the prosecution of the warrantor may be successful, are somewhat numerous and exacting. Prosecution would fail, for example, if the proceedings were taken more than six months after the warranty was given. The warrantor may claim that he is prejudiced by the absence of a control sample available for him. When he is proceeded against the whole case has to be gone into afresh, with the possibility of inconsistent conclusions. Moreover, the warrantor may make a sufficient defence if he can show that at the time of giving the warranty "he had reason to believe that the statements contained therein were true." These and other considerations in practice frequently deter local authorities from pursuing a case where the

Niven, 579-590.
Hope, 1171, 1193-1204.
Estcourt, 3955-8.
Sergeant, 4128.

Vol. I, Index,
"Food and Drugs Acts."
Vol. II. do.

Hope, 977, 1204.
Allen, 12,013-4.

Sale of Food and Drugs
Act, 1875, s. 25-27; 1899,
s. 20, &c.
Tattersall, 329-30.
Lithiby, 11,618-22.
Allen, 12,062, 12,017.

retailer has successfully set up the defence of warranty, and in consequence the person or firm responsible for the contamination is not reached at all.

Vol. I. Index,
"Food and Drugs Acts."
Vol. II. ^{REDA} do.

H. Smith, 10,929.
Lithiby, 11,519.
Allen, 12,008.

Tattersall, 28.
Estcourt, 4114.
Hehner, 8008-12.
C. Brown, 6931.
Allen, 12,005.

Hope, 925-6, 970-1.
Lithiby, 11,506, 11,634-40.
Allen, 12,005-8.

H. Smith, 8826-30.
Neech, 9193-7.

Lithiby, 11,498-506.
11,513-9, 11,537, 11,642-9.

Lithiby, 11,630-1.
Allen, 12,010-1.

154. (b) *Want of knowledge as to foods liable to contain deleterious substances*:—The Acts are generally regarded as intended to deal with certain well-known customs of fraudulent adulteration—for example, the dilution of milk or spirits with water, the abstraction of cream from milk, selling mixtures of coffee and chicory as coffee, and the like—rather than with risks to health from deleterious substances. The officers of local authorities who collect samples in the main direct their attention to cases of this sort. They have as a rule very little expert advice or direction which enables them to know what samples should be obtained as a control against substances injurious to health, or in what number these should be taken.

The Medical Officer of Health is seldom in position to afford advice of this kind; moreover, many authorities under the Sale of Food and Drugs Acts are County Councils which have not appointed a Medical Officer of Health. Public Analysts may possess special knowledge regarding methods of preparation of food stuffs, but it is no part of their official duty to advise as to the nature and number of samples which should be taken, and commonly their authorities do not invite their co-operation on the matter, even when they reside in the districts for which they are appointed analysts. As a rule, public analysts receive samples in order that they may pronounce upon their "genuineness" or otherwise, knowing nothing of the local circumstances which led to their being taken, of their origin, or of the reasons for sending them. The term "genuine" in this sense means that the analyst has not detected such objectionable substances as he has considered it necessary to look for in the sample submitted to him. Obviously the value of the statement that a sample is "genuine" depends upon the extent to which the analyst has means of knowing what are the objectionable substances which it is liable to contain. In present circumstances he has not sufficient information on this point. Different analysts may thus pronounce upon the genuineness of identical samples on widely different data.

155. The extent to which the Sale of Food and Drugs Acts are utilised by authorities charged with their administration varies within wide limits. These variations are obvious when the ratios which total samples taken under the Acts bear to the population is studied in different districts, and are still more striking when the corresponding ratios for particular foods are contrasted. Thus in particular instances no samples of beer were taken by local authorities under the Sale of Food and Drugs Acts even after the discovery of the cause of the epidemic of 1900. And when in February, 1902, we instituted inquiries at Halifax, where arsenical beer had lately been producing illness, we learnt that in that borough no sample of beer had been taken for public analysis for twelve months, and that similarly no beer samples had been taken during the same period in the neighbouring borough of Huddersfield.

156. The obligations in the matter of directing and supervising the work of local authorities, which have been imposed upon the Local Government Board under the Sale of Food and Drugs Acts, in general are of a limited character, although they have been enlarged in some respects by the Sale of Food and Drugs Acts of 1899, which enables the Board to take action in certain directions where a local authority fails to exercise its powers under the Acts. Hitherto the principal work of the Local Government Board in relation to the Sale of Food and Drugs Acts has consisted in sanctioning the appointment of public analysts, receiving annually copies of the quarterly reports made by public analysts to their local authorities, abstracting and tabulating these quarterly reports for the purposes of the Board's Annual Reports, and exerting pressure on authorities in cases where returns show that the

total number of samples taken under the Acts has been exceptionally small in proportion to the population of the districts concerned. When the cause of the 1900 epidemic was discovered, the Board, by circular, advised local authorities to collect samples of beer and certain other foods in order that these might be examined for arsenic. No statutory duty has, however, been imposed on the Local Government Board under the Sale of Food and Drugs Acts to advise local authorities as regards particular food substances which should receive attention either on account of particular methods of adulteration or of risk to health, and it has not hitherto been the Board's custom to take any systematic action in this direction.

157. (c) *Absence of official "standards."*—The application of the Sale of Food and Drugs Acts to prevention of contamination of foods by deleterious substances is materially hindered by want of an official authority with the duty of dealing with the various medical, chemical, and technical questions involved. At present there is no public authority to define, for example, impurities or adulterations which should be specifically looked for in course of examination of particular foods submitted for analysis under these Acts, or to lay down official "standards" for the use of all concerned, respecting the nature and extent of impurity or adulteration in a given food which, without question, should render its vendor or warrantor liable to proceedings under the Acts. Hence, when cases come before magistrates much conflicting expert evidence is often brought forward, and costly litigation, involving appeals to the High Court, frequently arises—conditions which may bear hardly on the person prosecuted, and which deter local authorities from taking action in the case of any unaccustomed form of adulteration or contamination.

Allen, 12,020-33, 12,013, 12,061.
C. Brown, Appx. 15.

158. In the case of foods liable to contain arsenic these drawbacks have been fully illustrated. Public Analysts, Medical Officers of Health, manufacturers, and other witnesses, have been practically unanimous in urging on the Commission the need for such official standards, and we consider their imposition essential to the successful use of the Sale of Food and Drugs Acts to prevent arsenical contamination.

Vol. I, Index,
"Official Control."
Hehner, 10,155-7.
Chapman, 10,290.
Allen 12,020.

159. PUBLIC HEALTH ACTS:—Some further means of control over the purity of finished foods is afforded by the power given to the Medical Officer of Health or Inspector of Nuisances in districts where Part III. of the Public Health Acts Amendment Act, 1890, has been adopted, to seize any article intended for human food which he has reason to believe is unwholesome or unfit for the food of man, with a view to its condemnation by a justice. In the opinion of witnesses whom we have examined on the point, these powers of seizure (which are mainly utilised in connection with rapidly perishable articles such as meat, fish, and vegetables) are hardly capable of satisfactory application where the proof that the article is deleterious is dependent on chemical analysis—particularly as the official would have no power to lay an embargo on the sale of a suspected article ending its chemical examination.

Niven, 741-8.
Hope, 975-6.
Reid, 1890-3.
Estcourt, 4046.
Lithiby 11,608-15.

Our evidence shows that the officials concerned did not consider these or other powers enabled them to secure the official seizure of arsenical beer in breweries after the cause of the 1900 epidemic was traced. The importance of this matter is illustrated by the fact that (notwithstanding the commendable promptness with which many of the implicated breweries acted on the discovery of the cause of the epidemic), beer contaminated by Bostock brewing sugars was in some cases sold many weeks after their dangerous character had become generally recognised. On inquiry in May, 1901, we ascertained that no action was taken by the local authority in the district in which the works of Messrs. Bostock & Co. were situated to seize or otherwise deal with the large quantity of contaminated glucose, "invert" sugar, and table syrup stored at these works after their poisonous nature had been discovered.

Estcourt, 4085-6
Allen, 12,035.

Williamson, 7324.
H. Smith, 10,971-82.

PART VII.

RECOMMENDATIONS AS TO IMPROVEMENTS IN OFFICIAL
CONTROL OVER THE PURITY OF FOOD.

160. We consider that the control which can at present be exercised in the restricted form already indicated (Part VI) is unsatisfactory when applied to the prevention of risk of contamination of foods by arsenic ; and further, that our evidence shows that serious defects exist in the machinery available to safeguard the public against the introduction of poisonous, deleterious, or valueless substances in general into articles of food. In view of the greater importance which administrative questions relative to the purity of food are rightly coming to assume (as evidenced by the number of occasions on which in recent years it has been necessary for Parliament or Government Departments to appoint Committees of Inquiry) we have thought it proper, in making our recommendations, to have regard to the broader issues concerned, and not merely to arsenic.

Cf. First Report, para. 33.

161. In particular, we have taken account of the inquiries of the Select Committee of the House of Commons which reported in 1896 on the Adulteration of Food Products, and of the Departmental Committee which reported in 1901 on Preservatives and Colouring Matters in Food, and to the recommendations for amendments in legislation and administration which have been made by these Committees.

162. Our conclusions on this part of our inquiry are as follows :—

(A) NECESSITY FOR MORE EXTENDED ADMINISTRATION BY THE LOCAL
GOVERNMENT BOARD.

163. There is need for efficient central administration in order that the system of control provided by the Sale of Food and Drugs Acts may be properly utilised, not only to protect the consumer against fraudulent adulteration, but also in the interests of the public health. The work of local authorities under these Acts should be co-ordinated : these authorities should have open to them better means of knowing whether a given food substance is liable to contamination or may become deleterious to health as a result of its method of manufacture or preparation for sale, and should have advice tendered to them as to the way in which the Acts may best be applied to secure the purity of food. Knowledge in the above sense is particularly needed with regard to new preparations of food, and to the large and increasing number and variety of food products made up in tins, packets and bottles ready for sale by the retailer. Many of these substances are now sold under fancy names without any indication of the ingredients which they contain, or of the substances used in their manufacture, and in present circumstances hardly any official control is exercised over the purity of these preparations. Even if samples of such foods are taken under the Sale of Food and Drugs Act, which is seldom the case, the analyst as a rule has no means of knowing whether particular deleterious matters should be specially looked for.

Hope, 1135-45, 1186-92.
Delépine, 5319.
C. Brown Appx. 15.

164. We have considered the suggestion of some witnesses that many of the present difficulties may be met by local public health authorities, by giving to their officers the duty of making inquiries as to conditions of food manufacture, either generally, in all places where food is prepared, or in particular instances where there is reason to believe that potentially dangerous ingredients, such as glucose or sulphuric acid, are used ; and that for this purpose these officers should be empowered to enter premises, inspect warranties and contracts, take samples, and the

like. It appears to us, however, that there are very serious objections to making the question one of purely local power and responsibility, even if the officers of the larger local authorities, County Councils and County Boroughs, were alone concerned. Many foods consumed within a county area, and which the county authority would need to deal with, would be manufactured outside that area, and powers given to local officials to inspect or make inquiries at food factories in any part of the kingdom would be practically unworkable, while these officers would be unable to obtain information regarding manufactured foods which are imported from abroad. Existing officers of county authorities in many instances would not be available for this additional duty, or would not possess the scientific and technical knowledge necessary for the satisfactory use of the powers of inspection. Moreover, our evidence shows that food manufacturers would be likely to resent inquiries by local officials as to the ingredients and processes which they employ; and they would properly object to inspection by officials of several different local authorities.

Garton, 6225.
Lyle, 11,144-7.

165. An alternative proposal is that the central public health authority, the Local Government Board, which at present is the Government Department mainly charged with supervising the administration of the Sale of Food and Drugs Acts, should undertake further duties of supervision and watchfulness in relation to the purity of foods and the administration of the Acts bearing on the subject.

At present the Local Government Board do not employ expert advice to guide them in dealing with the reports of public analysts which are sent to them, and therefore cannot make full use of their opportunities as an intelligence department in reference to questions arising under the Sale of Food and Drugs Acts. For the same reason the Board are unable to direct or advise local authorities as to the nature of samples which should be collected under the Sale of Food and Drugs Acts, or to secure that public analysts work in the same direction when pronouncing on the "genuineness" of such samples. In this connection it is instructive to note that, as a result of recent communications by the Board of Agriculture to local authorities, the check of public analysis on the adulteration of milk and butter has been largely increased throughout the country.

166. We are of opinion that the Local Government Board should take action in these matters, and that for this purpose they should have the advice of a special officer with suitable scientific knowledge, who should be in relation with the Government Laboratory, and be able to institute necessary chemical inquiries, and in other ways (for instance, where physiological investigations are necessary) have adequate laboratory assistance. In this way full and authoritative investigation could be made where new risks to health are suspected, or where new colouring matters, preservatives, or other chemical additions to food are introduced. Such officer, or his assistants, should have the duty not only of collecting information from public analysts and other local officers, and of advising how work under the Sale of Food and Drugs Acts may be run on satisfactory lines; but also of making inspections where necessary and of instituting inquiries as to conditions of manufacture of food in this country. He should also obtain all information possible regarding the manufacture of food stuffs imported from abroad, and should report annually. Under the improved conditions which we are considering, the Local Government Board should for food purposes be in touch with, and on occasion should obtain the co-operation of other departments of Government which would be able to render assistance in special directions—for instance, the Board of Inland Revenue in the case of articles subject to duty of excise, the Board of Customs in the case of imported foods, and the Patent Office in the case of patented processes of food preparation.

167. By these means we think that the Local Government Board would not only be able to advise and direct the work of local authorities

in the matter of securing the greater purity of food supplies in a way not hitherto attempted but also they would be able to make suggestions by way of reports, which will be of material assistance to the manufacturer who is anxious to secure the purity of his products, and to others concerned. The Board would further be able to secure that wider use is made of special work undertaken by public analysts in matters relating to food. It would seem more satisfactory that these officers should report annually, and if needed should also make special reports on particular subjects, than that the present system of routine quarterly reports should be continued.

168. We are satisfied from the evidence which we have received that many food manufacturers, some of whom would entertain considerable objection to inquiries by officers of local authorities with regard to the precautions taken to secure the purity of food, would be willing to afford facilities to a responsible officer of a Government Department charged with undertaking inquiries for the same purpose. Moreover, if it were necessary to seek powers from Parliament in order to give official right to enter all food factories, it would be more consistent with the general trend of modern legislation to grant such powers to the officers of a Government Department than to officers of local authorities.

B.—NECESSITY FOR OFFICIAL STANDARDS :—BOARD OF REFERENCE.

"Standards" for purposes of the Sale of Food and Drugs Acts.

169. We are of opinion that official standards must be prescribed if the Sale of Food and Drugs Acts are to be satisfactorily applied to control the purity of food. We term these "standards for the purpose of the Sale of Food and Drugs Acts," rather than "standards of purity," and in view of the considerations with regard to arsenic set out above in paragraphs 39-41, we think it important to insist upon the obvious distinction which has to be made in this respect. The standards we are considering are not models of purity for the manufacturers to aim at. Their object is to afford satisfactory means of judging whether in a given substance there has been substantial failure to secure purity, a failure which, on official authority, is held to call for the imposition of penalty.

For example, in relation to deleterious substances, where the offence lies in selling something not of the nature, substance and quality demanded by the purchaser, the "standard" would take the form of a definition of the minimum degree of purity which can be accepted as fulfilling the purchaser's demand—no more than so much boracic acid, no formalin, not more than so much arsenic, or whatever is necessary in the interests of the consumer to safeguard the particular food.

170. We consider that the Local Government Board (under advice as indicated in this Report), should be the authority to prescribe, and from time to time to vary, standards for the purposes of the Sale of Food and Drugs Acts.* Obviously, account would need be taken of sundry medical, physiological, chemical, and administrative questions in fixing such standards. It is necessary that these considerations should be properly balanced, and that manufacturers should be fairly dealt with. The means by which these requirements can be fulfilled were considered by the two Committees to which we have above referred. The Committee on Food Products Adulteration, which was mainly concerned with questions of preventing adulteration and impoverishment of food, and more recently, the Committee on Preservatives and

* Or the Board of Agriculture, where matters affecting the general interest of agriculture are concerned. Special duties in such cases have been imposed on the Board of Agriculture by the Sale of Food and Drugs Act, 1899; and certain standards have already been prescribed by this Board, in accordance with the provisions of the Act, and after inquiry by a Departmental Committee, in respect of milk and cream.

Garton, 6221-5.
Lyle, 11,060-2, 11,141-7.
Howell, 11,237-42.
Walker, 11,336-8.
Lithiby, 11,602-5.
Legge, 11,838-43.

Cf. paras. 157-8, above.

Colouring Matters in Food, alike came to the conclusion that food standards in certain instances were essential to efficient administration. Both Committees realised the impossibility of satisfactory standards being fixed by the central authority in the absence of full preliminary inquiry, and they recommended the establishment of a Board (Court, Permanent Commission or Standing Committee) of Reference, which should consist of a small number of scientific men, nominated by the Crown or departmentally, as the authority to advise on points arising in connection with the Sale of Food and Drugs Acts and requiring special expert consideration, and to prescribe the standards which should be fixed for the purposes of those Acts.

171. We are of opinion that if a Government department, the Local Government Board (or Board of Agriculture in cases where the general interests of agriculture are concerned) is to impose standards for the purposes of the Sale of Food and Drugs Acts, it is essential that its action should be based upon the advice of a scientific body of this nature. We do not think that the proposed Board of Reference should be an administrative body. It should be a consultative Board, available on the application of the Government department concerned, to pronounce on specific points which are specially referred to them. The findings of the Board of Reference in relation to standards and other matters should be carried into effect by order of the department concerned, whose action would be subject to the control of Parliament.

Lithiby, 11,542-6.

172. It has been objected that where questions related to a particular trade are concerned, manufacturers or technical experts in that trade ought to be represented on the Board of Reference, and that in view of the great variety of foods concerned, the Board of Reference would consequently have to be large and unwieldy. We do not think that there is much force in this objection, and we consider it would be more satisfactory for the Board of Reference to secure all technical information necessary in a given case by means of evidence and inquiry.

"Standards" for Ingredients and substances used in the preparation of food.

173. Standards are also demanded in the interests of the public health, and of the manufacturer, in respect of particular ingredients of food, or substances used in the preparation of food. The importance of official standards for these substances (for example, standards as to arsenic in sulphuric acid, glucose, malt, or colouring matters, fixed with regard to the degree of purity attainable in the substances themselves, irrespective of the extent to which they may be used in the manufacture of particular articles of food) has been fully illustrated by our inquiry, and we think that such standards should also be prescribed in the manner above indicated.

Cf. para. 136, above.

174. The "standards" in this case would define substances, which, on account of their own deleterious properties, or of contamination by particular deleterious impurities, should be considered as inadmissible in the preparation of any article of food.

175. Witnesses have recommended in several instances, not only that standards of this kind should be prescribed, but also that manufacturers of food or food ingredients in this country should be prohibited under penalty from using substances which transgress these standards. At present, as we have stated above, there exists, in general, no system of control by which such official prohibitions could be enforced at places where food and its ingredients are prepared. And it is probable that considerable difficulties would arise in legislation and administration to secure adequate official inspection for this purpose. It is obvious that the main object of the inspection by an officer of the Local Government Board which we have advocated should be rather to obtain general information as to the nature of processes carried on and as to the sufficiency of the system of precaution adopted to secure pure ingredients,

*Salamon, 10,009.
H. Smith, 10,923-33.
Delépine, 5319.*

than to attempt systematic supervision over the everyday proceedings of the manufacturer with a view to detecting offences which would render him subject to legal proceedings.

176. However this may be, there should be no difficulty in arriving at standards which will be of assistance to the manufacturer in preparing or in ordering substances used in food preparation, and it may be expected that ordinarily a standard officially recommended after careful inquiry (for example, as to arsenic in glucose or in sulphuric acid used for food purposes) would be adopted by manufacturers and would be required by wholesale purchasers in their own interests and apart from penalty; more especially if, under the improved conditions of administration above considered, the control over deleterious substances afforded by public analysis of the finished product was strengthened, and the manufacturer was aware that official inquiry might be made as to his precautions.

177. The control over arsenical contamination recently exercised in breweries by the action of the Board of Inland Revenue (para. 149), and which, in our opinion, should be continued, will facilitate the general adoption of official standards which may in future be prescribed in respect of arsenic in beer ingredients.

178. We would briefly indicate the application of the recommendation of the foregoing paragraphs 163 to 177 to the case of arsenic in food. Under the above scheme, it would form part of the duty of the expert officer appointed by the Local Government Board for food purposes to advise the Board as to risks from arsenic in particular foods and materials used in the preparation of foods, as to risks newly discovered (particularly in regard of new preparations of food and new ingredients and methods), and as to the extent and nature of the control, central and local, which is necessary to guard against these risks. For these purposes he would utilise various sources of information available to him in course of his official work—information obtained for example, from the Government Laboratory and other Government Departments; from Medical Officers of Health and Public Analysts; from the Board's own inquiries of manufacturers; and from chemical work conducted in the Government Laboratory or otherwise for the Board. In the case of beer or of other articles subject to duty, he would keep himself informed of the system of control adopted by the Board of Inland Revenue.

179. The Local Government Board thus advised would be in position to deal with risks of arsenical contamination as part of their administration of the Sale of Food and Drugs Acts, by (a) Publication of special reports, and warning manufacturers, by circular or otherwise, where precautions appeared inadequate. (b) Prescribing by Order, on the authority of the Board of Reference, the quantities of arsenic (ascertained by particular tests) which if exceeded in given classes of food should entail penalty under the Sale of Food and Drugs Acts. (c) Securing by advice or instructions to Local Authorities, Analysts, and other executive officers, that the check of public analysis is properly and sufficiently applied to foods liable to arsenical contamination. (d) Defining, on the authority of the Board of Reference, standards in respect of arsenic in ingredients of food, and in substances used in the preparation of food, for adoption by the manufacturer and user of such substances.

C.—RESPONSIBILITY OF MANUFACTURER OR INTERMEDIATE VENDOR UNDER THE SALE OF FOOD AND DRUGS ACTS.

180. The nature of the amendment of the Sale of Food and Drugs Acts which we consider necessary for this purpose may be stated as follows:—

If, in a prosecution instituted under the Sale of Food and Drugs Acts, it is alleged by defendant A that the article was sold in the

condition in which it was supplied to him by B (*e.g.*, the manufacturer, importer, or giver of warranty); or that the contamination is due to an ingredient supplied by C; it should be possible for A to attach B (or C as the case may be) to the prosecution. The same principle should apply to the person thus associated in the defence, if he in his turn alleges that a third party is responsible, by breach of warranty or otherwise, for the adulteration or contamination of the final product.

We think that if the whole of the facts are thus brought before the Court at one hearing, responsibility can be properly brought home to the real offender in a way not at present possible. In making this recommendation we have had in mind the precedents which are afforded by Section 12 of the Truck Act, 1887, and by Section 141 of the Factory and Workshop Act, 1901.

D.—POWERS OF LOCAL AUTHORITIES TO PREVENT THE SALE OF SUSPECTED FOODS PENDING ANALYSIS.

181. We think that the powers which Medical Officers of Health at present possess under the Public Health Acts to obtain the condemnation of unsound or unwholesome articles of food should be extended. Where the Medical Officer of Health has good reason for believing that particular articles of food or ingredients of food have caused, or are liable to cause, injury to health, but is of opinion that analysis of samples is necessary before the facts can be fully established, powers should be given to lay an embargo on the sale of the suspected articles or on the use of the suspected ingredients, pending their official examination. The grant of these powers should be accompanied by the requirement that a Justice's order should be obtained, or by other provisions which are adequate to prevent their being used unnecessarily or improperly.

Cf. para. 159, above.

PART VIII.

PROPORTIONS OF ARSENIC IN FOOD WHICH SHOULD
CONSTITUTE AN OFFENCE UNDER THE SALE OF
FOOD AND DRUGS ACTS.

182. Pending the establishment of official standards in respect of arsenic under the Sale of Food and Drugs Acts, the evidence we have received fully justifies us in pronouncing certain quantities of arsenic in beer and in other foods as liable to be deleterious, and at the same time capable of exclusion, with comparative ease, by the careful manufacturer. In our view it would be entirely proper that penalties should be imposed under the Sale of Food and Drugs Acts upon any vendor of beer or any other liquid food, or of any liquid entering into the composition of food, if that liquid is shown by an adequate test to contain $\frac{1}{100}$ th of a grain or more of arsenic in the gallon; and with regard to solid food—no matter whether it is habitually consumed in large or in small quantities, or whether it is taken by itself (like golden syrup) or mixed with water or other substances (like chicory or “carnos”)—if the substance is shown by an adequate test to contain $\frac{1}{100}$ th grain of arsenic or more in the pound.

All which we humbly submit for your Majesty's gracious consideration.

(Signed) KELVIN, *Chairman*.

W. HART DYKE.

W. S. CHURCH.

T. E. THORPE.

H. COSMO BONSOR.

B. A. WHITELEGGE.

G. S. BUCHANAN, *Secretary*,

6th November 1903.

MEMORANDUM BY DR. THORPE.

I concur in the Report, except as regards one portion of the Section relating to official standards and the suggested Board of Reference. Part VII., B, pp. 46-7.

Although the whole question of Official Standards of "food-purity" or genuineness is surrounded with difficulties, many authorities doubting the wisdom and expediency of setting them up, I incline to the opinion that the successful working of the Food and Drugs Acts requires them to be prescribed.

Such official standards have usually regard to a deficiency, to the prejudice of the purchaser, in some normal constituent or constituents. Now before any official standard or limits, in any particular instance, can be prescribed, it is necessary to ascertain how much of the constituents the article ought normally to contain, and then, having regard to all the conditions of supply and distribution, to fix upon a limit or standard which is reasonable and practicable.

To arrive at a just and satisfactory compromise—for the great majority of such food standards are and necessarily must be of the nature of compromises—is frequently a very difficult and intricate problem and needs for its solution knowledge and experience, not only of the composition of the substance, the extent to which that composition may legitimately vary, and the causes and frequency of such variation, but also of the actual conditions of its production and distribution.

For example, to determine what deficiency in the amount of fat, or of non-fatty solids in milk, or what deficiency in the amount of the characteristic constituents of butter, or what proportion of water in butter, shall, for the purposes of the Sale of Food and Drugs Acts, raise a presumption that the milk or butter is not genuine, may appear a very simple problem to anyone who has not been actually engaged in the attempt to solve it. In reality when due regard is had to the various and complex considerations which affect the matter it is by no means simple. Experience has shown that to solve it adequately and in a manner calculated to secure public confidence, its consideration is best entrusted to persons of special knowledge and experience of the article for which a "standard" is required.

In the Food and Drugs Act of 1899 the Board of Agriculture took powers to make regulations, after such inquiry as they may deem necessary, for determining when a presumption shall be raised that milk, cream, butter, or cheese are not genuine. In cases of the kind the Board has appointed an *ad hoc* Committee to consider in the first place whether any regulations at all were desirable, and if so, to determine the principles on which the regulations should be based, and the Board has taken care in constituting the Committee that every interest and every class of consideration should be adequately regarded.

I venture to think, therefore, that instead of creating a permanent Committee consisting of a small number of scientific men, as the authority to prescribe the standards which should be fixed for the purposes of the Sale of Food and Drugs Acts, it would be preferable to follow the procedure of the Board of Agriculture and to entrust the consideration of the propriety of fixing a standard, or standards in the case of particular groups of allied substances, to specially constituted Committees in which manufacturers and technical experts in the trade concerned were represented. Considering the very large and legitimate commercial interests involved, I am of opinion that no other course would be satisfactory.

There is, however, a class of questions connected with public health which have no relation to the natural variations in quality of

articles of food, and which might properly be referred to such a body as is contemplated in the Report. These matters are intended to be dealt with under Section 3 of the 1875 Act, which is concerned with the adulteration of articles of food with substances injurious to health. The substances so added are not, as a rule, naturally present in food, and are not of the nature of food, *e.g.*, mineral colouring matters, so-called aniline dyes, antiseptics, &c.

The Departmental Committee appointed by the Local Government Board in 1899, to inquire into the use of preservatives and colouring matters in the preservation and colouring of food, were of opinion that a body such as is contemplated would prove most useful with regard to the subject of food preservatives and colouring matters in food. This body in their opinion "should not be too large, but should embrace at least a chemist, a bacteriologist, a pharmacologist, a physician, a physiologist, and a representative of the Public Health Service." A body so constituted would, of course, be perfectly competent to deal with such questions as the permissible limit of arsenic in food, and whether the use of preservatives and colouring matters in food is injurious to health; but it is open to doubt whether it would be equally competent to deal with such questions as what proportion of husk in ground pepper, or what proportion of starch-glucose in golden syrup, or what proportion of beef-stearin in lard, shall raise a presumption that these articles are not of the nature, substance, and quality demanded by the purchaser.

T. E. THORPE.

14th November, 1903.